Weight Lifting Exercise-2

This human activity recognition research has traditionally focused on discriminating between different activities, i.e. to predict "which" activity was performed at a specific point in time (like with the Daily Living Activities dataset above). The approach we propose for the Weight Lifting Exercises dataset is to investigate "how (well)" an activity was performed by the wearer. The "how (well)" investigation has only received little attention so far, even though it potentially provides useful information for a large variety of applications, such as sports training.

2. Perform the below given activities:

a. Create classification model using logistic regression model
b. verify model goodness of fit
c. Report the accuracy measures
d. Report the variable importance
e. Report the unimportant variables
f. Interpret the results
g. Visualize the results

setwd("C:/Users/Seshan/Desktop")

library(readr)

```r
Weight_lift <- read.csv("Weight lift.csv")

View(Weight_lift)

str(Weight_lift)

data<-Weight_lift

# load libraries

library(caret)

library(randomForest)

library(rpart)

library(rpart.plot)

library(ggplot2)

library(lattice)

library(rattle)


library(C50)

#install.package('devtools') # Only needed if you dont have this installed.

library(devtools)

install_github('adam-m-mcelhinney/helpRFunctions')

library(helpRFunctions)

names(data)

dim(data)

pairs(data[1:10])

# enable multi-core processing

library(doParallel)

cl <- makeCluster(detectCores())

registerDoParallel()
```

```r
set.seed(12345)

dataTrain<-data[1:4004,]

dataTest<-data[4005:4024,]

head(dataTrain)

head(dataTest)

indexNA <- as.vector(sapply(dataTrain[,1:158],function(x) {length(which(is.na(x)))!=0}))

dataTrain <- dataTrain[,!indexNA]

train_control<- trainControl(method="cv", number=10)


model<- train(classe ~., data=dataTrain,trControl=train_control, method="rf")

model

# make predictions

predictions<- predict(model,dataTrain)

# append predictions

pred<- cbind(dataTrain,predictions)

# summarize results

confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)

confusionMatrix

#how do we create a cross validation scheme

control <- trainControl(method = 'repeatedcv',

                number = 10,

                repeats = 3)

seed <-7

metric <- 'Accuracy'

set.seed(seed)
```

```r
mtry <- sqrt(ncol(dataTrain))

tunegrid <- expand.grid(.mtry=mtry)

rf_default <- train(pitch_belt~.,

        data = dataTrain,

        method = 'rf',

        metric = 0,

        tuneGrid = tunegrid,

        trControl = control)

print(rf_default)

#-----------------------------


# make predictions

predictions<- predict(rf_default,dataTest)

# append predictions

pred<- cbind(dataTest,predictions)

# summarize results

confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)

confusionMatrix

varImp(rf_default)

#----------------

# random search for parameters

control <- trainControl(method = 'repeatedcv',

        number = 10,

        repeats = 3,

        search = 'random')
```

```r
# make predictions

predictions<- predict(rf_default,dataTest)


# append predictions

pred<- cbind(dataTest,predictions)


# summarize results

#confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)

confusionMatrix

varImp(random)

#--------------------


# Grid search

control <- trainControl(method = 'repeatedcv',

            number = 10,

             repeats = 3,

             search = 'grid')

set.seed(seed)

tunegrid <- expand.grid(.mtry=c(1:80))

mtry <- sqrt(ncol(x))

rf_gridsearch <- train(~.,

            data = dataTrain[1:200,],

            method = 'rf',

             metric = 0,

            tuneGrid = tunegrid,
```

```r
              trControl = control)

print(rf_gridsearch)

plot(rf_gridsearch)

# make predictions

predictions<- predict(rf_gridsearch,dataTest)


# append predictions

pred<- cbind(dataTest,predictions)


# summarize results

confusionMatrix<- confusionMatrix(pred$predictions,pred$pitch_belt)

confusionMatrix

varImp(rf_gridsearch)



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  # Boosting

  # -------------------------------------

# Boosting model requires three things


#1- a loss function to be optimized

#2- a weak learner to make predictions

#3- an additive model to add the weak learners to minimize the loss function


# gradient boosting

control <- trainControl(method = 'repeatedcv',
```

```r
                number = 5,

                repeats = 3,

                search = 'grid')


seed <- 7

library(C50)

set.seed(seed)

metric <- 'Accuracy'

gbm_mod <- train(pitch_belt~.,

        data = dataTrain,

        method = 'gbm',

        metric = 0,

        trControl = control)

print(gbm_mod)

plot(gbm_mod)


summary(gbm_mod)
# make predictions

predictions<- predict(gbm_mod,dataTest)


# append predictions

pred<- cbind(dataTest,predictions)


# summarize results

confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)
```

confusionMatrix

```
> setwd("C:/Users/Seshan/Desktop")
> library(readr)
> Weight_lift <- read.csv("Weight lift.csv")
> View(Weight_lift)
> str(Weight_lift)
'data.frame':   4024 obs. of  158 variables:
 $ user_name             : Factor w/ 5 levels "adelmo","carlitos",..: 3 3 3
3 3 3 3 3 3 3 ...
 $ raw_timestamp_part_1  : int  1322489729 1322489729 1322489729 1322489729
1322489729 1322489729 1322489729 1322489729 1322489729 1322489729 ...
 $ raw_timestamp_part_2  : int  34670 62641 70653 82654 90637 170626 190665
242723 267551 274689 ...
 $ cvtd_timestamp        : Factor w/ 7 levels "2/12/2011 13:35",..: 2 2 2 2
2 2 2 2 2 2 ...
 $ new_window            : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1
1 ...
 $ num_window            : int  1 1 1 1 1 1 1 1 1 1 ...
 $ roll_belt             : num  3.7 3.66 3.58 3.56 3.57 3.45 3.31 2.91 2.31
2 ...
 $ pitch_belt            : num  41.6 42.8 43.7 44.4 45.1 45.6 46.2 46.9 47.
4 47.7 ...
 $ yaw_belt              : num  -82.8 -82.5 -82.3 -82.1 -81.9 -81.9 -81.9 -
82.2 -82.6 -82.8 ...
 $ total_accel_belt      : int  3 2 1 1 1 1 3 4 2 3 ...
 $ kurtosis_roll_belt    : num  -1.04 -1.04 -1.04 -1.04 -1.04 ...
 $ kurtosis_picth_belt   : num  -0.391 -0.391 -0.391 -0.391 -0.391 ...
 $ skewness_roll_belt    : num  0.00541 0.00541 0.00541 0.00541 0.00541 ...
 $ skewness_roll_belt.1  : num  0.0451 0.0451 0.0451 0.0451 0.0451 ...
 $ max_roll_belt         : num  -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.
1 -4.1 ...
 $ max_picth_belt        : int  20 20 20 20 20 20 20 20 20 20 ...
 $ max_yaw_belt          : num  -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ...
 $ min_roll_belt         : num  -7.25 -7.25 -7.25 -7.25 -7.25 -7.25 -7.25 -
7.25 -7.25 -7.25 ...
 $ min_pitch_belt        : int  18 18 18 18 18 18 18 18 18 18 ...
 $ min_yaw_belt          : num  -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ...
 $ amplitude_roll_belt   : num  1.34 1.34 1.34 1.34 1.34 ...
 $ amplitude_pitch_belt  : int  2 2 2 2 2 2 2 2 2 2 ...
 $ amplitude_yaw_belt    : int  0 0 0 0 0 0 0 0 0 0 ...
 $ var_total_accel_belt  : num  0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 ...
 $ avg_roll_belt         : num  122 122 122 122 122 ...
 $ stddev_roll_belt      : num  0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 ...
 $ var_roll_belt         : num  0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.3
5 0.35 ...
 $ avg_pitch_belt        : num  25.8 25.8 25.8 25.8 25.8 ...
 $ stddev_pitch_belt     : num  0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.3
5 0.35 ...
 $ var_pitch_belt        : num  0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 ...
 $ avg_yaw_belt          : num  -4.95 -4.95 -4.95 -4.95 -4.95 -4.95 -4.95 -
4.95 -4.95 -4.95 ...
 $ stddev_yaw_belt       : num  0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 ...
```

```
 $ var_yaw_belt          : num  0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.1
7 0.17 ...
 $ gyros_belt_x          : num  2.02 1.96 1.88 1.8 1.77 1.75 1.78 1.75 1.65
1.48 ...
 $ gyros_belt_y          : num  0.18 0.14 0.08 0.03 0 -0.03 -0.06 -0.06 -0.
03 -0.06 ...
 $ gyros_belt_z          : num  0.02 0.05 0.05 0.08 0.13 0.16 0.15 0.23 0.3
3 0.21 ...
 $ accel_belt_x          : int  -3 -2 -2 -6 -4 1 1 2 -1 -18 ...
 $ accel_belt_y          : int  -18 -13 -6 -5 -9 -9 -24 -36 -19 18 ...
 $ accel_belt_z          : int  22 16 8 7 0 -5 -8 -9 -7 1 ...
 $ magnet_belt_x         : int  387 405 409 422 418 432 438 440 443 449 ...
 $ magnet_belt_y         : int  525 512 511 513 508 510 508 503 507 499 ...
 $ magnet_belt_z         : int  -267 -254 -244 -221 -208 -189 -176 -163 -14
0 -132 ...
 $ roll_arm              : num  132 129 125 120 115 110 104 98.6 93.2 88.5
...
 $ pitch_arm             : num  -43.7 -45.3 -46.8 -48.1 -49.1 -49.6 -49.9 -
49.7 -49 -48.1 ...
 $ yaw_arm               : num  -53.6 -49 -43.7 -38.1 -31.7 -25.8 -18.5 -11
.4 -4.49 1.82 ...
 $ total_accel_arm       : int  38 38 35 35 34 33 29 28 27 22 ...
 $ var_accel_arm         : num  65.1 65.1 65.1 65.1 65.1 ...
 $ avg_roll_arm          : num  76.2 76.2 76.2 76.2 76.2 ...
 $ stddev_roll_arm       : num  16.1 16.1 16.1 16.1 16.1 ...
 $ var_roll_arm          : num  259 259 259 259 259 ...
 $ avg_pitch_arm         : num  -10.2 -10.2 -10.2 -10.2 -10.2 ...
 $ stddev_pitch_arm      : num  10.7 10.7 10.7 10.7 10.7 ...
 $ var_pitch_arm         : num  114 114 114 114 114 ...
 $ avg_yaw_arm           : num  19.1 19.1 19.1 19.1 19.1 ...
 $ stddev_yaw_arm        : num  35.9 35.9 35.9 35.9 35.9 ...
 $ var_yaw_arm           : num  1287 1287 1287 1287 1287 ...
 $ gyros_arm_x           : num  2.65 2.79 2.91 3.08 3.2 3.31 3.5 3.53 3.4 3
.48 ...
 $ gyros_arm_y           : num  -0.61 -0.64 -0.69 -0.72 -0.77 -0.83 -0.83 -
0.83 -0.83 -0.8 ...
 $ gyros_arm_z           : num  -0.02 -0.11 -0.15 -0.23 -0.25 -0.3 -0.31 -0
.21 -0.11 -0.15 ...
 $ accel_arm_x           : int  143 146 156 158 163 160 165 153 143 135 ...
 $ accel_arm_y           : int  30 35 44 52 55 59 67 70 78 96 ...
 $ accel_arm_z           : int  -346 -339 -307 -305 -288 -274 -225 -218 -20
5 -134 ...
 $ magnet_arm_x          : int  556 599 613 646 670 696 721 725 740 741 ...
 $ magnet_arm_y          : int  -205 -206 -198 -186 -175 -174 -161 -152 -13
3 -115 ...
 $ magnet_arm_z          : int  -374 -335 -319 -268 -241 -193 -121 -105 -43
14 ...
 $ kurtosis_roll_arm     : num  -1.18 -1.18 -1.18 -1.18 -1.18 ...
 $ kurtosis_picth_arm    : num  -0.969 -0.969 -0.969 -0.969 -0.969 ...
 $ kurtosis_yaw_arm      : num  -0.87 -0.87 -0.87 -0.87 -0.87 ...
 $ skewness_roll_arm     : num  0.124 0.124 0.124 0.124 0.124 ...
 $ skewness_pitch_arm    : num  -0.103 -0.103 -0.103 -0.103 -0.103 ...
 $ skewness_yaw_arm      : num  0.0598 0.0598 0.0598 0.0598 0.0598 ...
 $ max_roll_arm          : num  8.45 8.45 8.45 8.45 8.45 8.45 8.45 8.45 8.4
5 8.45 ...
 $ max_picth_arm         : num  77.2 77.2 77.2 77.2 77.2 ...
 $ max_yaw_arm           : int  38 38 38 38 38 38 38 38 38 38 ...
```

```
 $ min_roll_arm          : num  -33.6 -33.6 -33.6 -33.6 -33.6 -33.6 -33.6 -
33.6 -33.6 -33.6 ...
 $ min_pitch_arm         : num  -58.6 -58.6 -58.6 -58.6 -58.6 -58.6 -58.6 -
58.6 -58.6 -58.6 ...
 $ min_yaw_arm           : int  10 10 10 10 10 10 10 10 10 10 ...
 $ amplitude_roll_arm    : num  36.9 36.9 36.9 36.9 36.9 ...
 $ amplitude_pitch_arm   : num  122 122 122 122 122 ...
 $ amplitude_yaw_arm     : int  27 27 27 27 27 27 27 27 27 27 ...
 $ roll_dumbbell         : num  51.2 55.8 55.5 55.9 55.2 ...
 $ pitch_dumbbell        : num  11.7 9.65 6.88 11.08 11.43 ...
 $ yaw_dumbbell          : num  104.3 100.2 101.1 99.8 100.4 ...
 $ kurtosis_roll_dumbbell  : num  -0.0959 -0.0959 -0.0959 -0.0959 -0.0959 ...
 $ kurtosis_picth_dumbbell : num  -0.442 -0.442 -0.442 -0.442 -0.442 ...
 $ skewness_roll_dumbbell  : num  0.0819 0.0819 0.0819 0.0819 0.0819 0.0819 0
.0819 0.0819 0.0819 0.0819 ...
 $ skewness_pitch_dumbbell : num  -0.216 -0.216 -0.216 -0.216 -0.216 -0.216 -
0.216 -0.216 -0.216 -0.216 ...
 $ max_roll_dumbbell     : num  41.9 41.9 41.9 41.9 41.9 ...
 $ max_picth_dumbbell    : num  133 133 133 133 133 133 133 133 133 133 ...
 $ max_yaw_dumbbell      : num  -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.
1 -0.1 ...
 $ min_roll_dumbbell     : num  -26.8 -26.8 -26.8 -26.8 -26.8 ...
 $ min_pitch_dumbbell    : num  20.2 20.2 20.2 20.2 20.2 20.2 20.2 20.2 20.
2 20.2 ...
 $ min_yaw_dumbbell      : num  -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.
1 -0.1 ...
 $ amplitude_roll_dumbbell : num  55.7 55.7 55.7 55.7 55.7 ...
 $ amplitude_pitch_dumbbell: num  54.7 54.7 54.7 54.7 54.7 ...
 $ amplitude_yaw_dumbbell  : int  0 0 0 0 0 0 0 0 0 0 ...
 $ total_accel_dumbbell  : int  4 4 4 5 4 4 4 4 4 4 ...
 $ var_accel_dumbbell    : num  2.42 2.42 2.42 2.42 2.42 ...
 $ avg_roll_dumbbell     : num  -5.12 -5.12 -5.12 -5.12 -5.12 ...
  [list output truncated]
> data<-Weight_lift
> # load libraries
> library(caret)
> library(randomForest)
> library(rpart)
> library(rpart.plot)
> library(ggplot2)
> library(lattice)
> library(rattle)
>
> library(C50)
> #install.package('devtools') # Only needed if you dont have this installed.
> library(devtools)
> install_github('adam-m-mcelhinney/helpRFunctions')
Skipping install of 'helpRFunctions' from a github remote, the SHA1 (9eb16e8c
) has not changed since last install.
  Use `force = TRUE` to force installation
> library(helpRFunctions)
> names(data)
 [1] "user_name"              "raw_timestamp_part_1"      "raw_timestamp_pa
rt_2"
 [4] "cvtd_timestamp"         "new_window"                "num_window"
 [7] "roll_belt"              "pitch_belt"                "yaw_belt"
```

```
 [10] "total_accel_belt"        "kurtosis_roll_belt"        "kurtosis_picth_b
elt"
 [13] "skewness_roll_belt"       "skewness_roll_belt.1"      "max_roll_belt"
 [16] "max_picth_belt"           "max_yaw_belt"              "min_roll_belt"
 [19] "min_pitch_belt"           "min_yaw_belt"              "amplitude_roll_b
elt"
 [22] "amplitude_pitch_belt"     "amplitude_yaw_belt"        "var_total_accel_
belt"
 [25] "avg_roll_belt"            "stddev_roll_belt"          "var_roll_belt"
 [28] "avg_pitch_belt"           "stddev_pitch_belt"         "var_pitch_belt"
 [31] "avg_yaw_belt"             "stddev_yaw_belt"           "var_yaw_belt"
 [34] "gyros_belt_x"             "gyros_belt_y"              "gyros_belt_z"
 [37] "accel_belt_x"             "accel_belt_y"              "accel_belt_z"
 [40] "magnet_belt_x"            "magnet_belt_y"             "magnet_belt_z"
 [43] "roll_arm"                 "pitch_arm"                 "yaw_arm"
 [46] "total_accel_arm"          "var_accel_arm"             "avg_roll_arm"
 [49] "stddev_roll_arm"          "var_roll_arm"              "avg_pitch_arm"
 [52] "stddev_pitch_arm"         "var_pitch_arm"             "avg_yaw_arm"
 [55] "stddev_yaw_arm"           "var_yaw_arm"               "gyros_arm_x"
 [58] "gyros_arm_y"              "gyros_arm_z"               "accel_arm_x"
 [61] "accel_arm_y"              "accel_arm_z"               "magnet_arm_x"
 [64] "magnet_arm_y"             "magnet_arm_z"              "kurtosis_roll_ar
m"
 [67] "kurtosis_picth_arm"       "kurtosis_yaw_arm"          "skewness_roll_ar
m"
 [70] "skewness_pitch_arm"       "skewness_yaw_arm"          "max_roll_arm"
 [73] "max_picth_arm"            "max_yaw_arm"               "min_roll_arm"
 [76] "min_pitch_arm"            "min_yaw_arm"               "amplitude_roll_a
rm"
 [79] "amplitude_pitch_arm"      "amplitude_yaw_arm"         "roll_dumbbell"
 [82] "pitch_dumbbell"           "yaw_dumbbell"              "kurtosis_roll_du
mbbell"
 [85] "kurtosis_picth_dumbbell"  "skewness_roll_dumbbell"    "skewness_pitch_d
umbbell"
 [88] "max_roll_dumbbell"        "max_picth_dumbbell"        "max_yaw_dumbbell
"
 [91] "min_roll_dumbbell"        "min_pitch_dumbbell"        "min_yaw_dumbbell
"
 [94] "amplitude_roll_dumbbell"  "amplitude_pitch_dumbbell"  "amplitude_yaw_du
mbbell"
 [97] "total_accel_dumbbell"     "var_accel_dumbbell"        "avg_roll_dumbbel
l"
[100] "stddev_roll_dumbbell"     "var_roll_dumbbell"         "avg_pitch_dumbbe
ll"
[103] "stddev_pitch_dumbbell"    "var_pitch_dumbbell"        "avg_yaw_dumbbell
"
[106] "stddev_yaw_dumbbell"      "var_yaw_dumbbell"          "gyros_dumbbell_x
"
[109] "gyros_dumbbell_y"         "gyros_dumbbell_z"          "accel_dumbbell_x
"
[112] "accel_dumbbell_y"         "accel_dumbbell_z"          "magnet_dumbbell_
x"
[115] "magnet_dumbbell_y"        "magnet_dumbbell_z"         "roll_forearm"
[118] "pitch_forearm"            "yaw_forearm"               "kurtosis_roll_fo
rearm"
[121] "kurtosis_picth_forearm"   "skewness_roll_forearm"     "skewness_pitch_f
orearm"
```

```
[124] "max_roll_forearm"          "max_picth_forearm"          "max_yaw_forearm"
[127] "min_roll_forearm"          "min_pitch_forearm"          "min_yaw_forearm"
[130] "amplitude_roll_forearm"    "amplitude_pitch_forearm"    "amplitude_yaw_fo
rearm"
[133] "total_accel_forearm"       "var_accel_forearm"          "avg_roll_forearm
"
[136] "stddev_roll_forearm"       "var_roll_forearm"           "avg_pitch_forear
m"
[139] "stddev_pitch_forearm"      "var_pitch_forearm"          "avg_yaw_forearm"
[142] "stddev_yaw_forearm"        "var_yaw_forearm"            "gyros_forearm_x"
[145] "gyros_forearm_y"           "gyros_forearm_z"            "accel_forearm_x"
[148] "accel_forearm_y"           "accel_forearm_z"            "magnet_forearm_x
"
[151] "magnet_forearm_y"          "magnet_forearm_z"           "accel_forearm_y.
1"
[154] "accel_forearm_z.1"         "magnet_forearm_x.1"         "magnet_forearm_y
.1"
[157] "magnet_forearm_z.1"        "classe"
> dim(data)
[1] 4024  158
> pairs(data[1:10])



> # enable multi-core processing
> library(doParallel)
> cl <- makeCluster(detectCores())
> registerDoParallel()
> set.seed(12345)
> dataTrain<-data[1:4004,]
> dataTest<-data[4005:4024,]
> head(dataTrain)
  user_name raw_timestamp_part_1 raw_timestamp_part_2  cvtd_timestamp new_wi
ndow
1    eurico           1322489729                34670 28/11/2011 14:15
no
2    eurico           1322489729                62641 28/11/2011 14:15
no
3    eurico           1322489729                70653 28/11/2011 14:15
no
4    eurico           1322489729                82654 28/11/2011 14:15
no
5    eurico           1322489729                90637 28/11/2011 14:15
no
6    eurico           1322489729               170626 28/11/2011 14:15
no
  num_window roll_belt pitch_belt yaw_belt total_accel_belt kurtosis_roll_bel
t
1          1      3.70       41.6    -82.8                3           -1.0356
6
2          1      3.66       42.8    -82.5                2           -1.0356
6
3          1      3.58       43.7    -82.3                1           -1.0356
6
4          1      3.56       44.4    -82.1                1           -1.0356
6
5          1      3.57       45.1    -81.9                1           -1.0356
6
```

6	1	3.45	45.6	-81.9	1	-1.03566

	kurtosis_picth_belt	skewness_roll_belt	skewness_roll_belt.1	max_roll_belt
1	-0.39133	0.005406	0.045115	-4.1
2	-0.39133	0.005406	0.045115	-4.1
3	-0.39133	0.005406	0.045115	-4.1
4	-0.39133	0.005406	0.045115	-4.1
5	-0.39133	0.005406	0.045115	-4.1
6	-0.39133	0.005406	0.045115	-4.1

	max_picth_belt	max_yaw_belt	min_roll_belt	min_pitch_belt	min_yaw_belt
1	20	-1	-7.25	18	-1
2	20	-1	-7.25	18	-1
3	20	-1	-7.25	18	-1
4	20	-1	-7.25	18	-1
5	20	-1	-7.25	18	-1
6	20	-1	-7.25	18	-1

	amplitude_roll_belt	amplitude_pitch_belt	amplitude_yaw_belt	var_total_accel_belt
1	1.345	2	0	0.3
2	1.345	2	0	0.3
3	1.345	2	0	0.3
4	1.345	2	0	0.3
5	1.345	2	0	0.3
6	1.345	2	0	0.3

	avg_roll_belt	stddev_roll_belt	var_roll_belt	avg_pitch_belt	stddev_pitch_belt
1	121.9	0.6	0.35	25.75	0.35
2	121.9	0.6	0.35	25.75	0.35
3	121.9	0.6	0.35	25.75	0.35
4	121.9	0.6	0.35	25.75	0.35
5	121.9	0.6	0.35	25.75	0.35
6	121.9	0.6	0.35	25.75	0.35

	var_pitch_belt	avg_yaw_belt	stddev_yaw_belt	var_yaw_belt	gyros_belt_x	gyros_belt_y
1	0.1	-4.95	0.4	0.17	2.02	0.18
2	0.1	-4.95	0.4	0.17	1.96	0.14
3	0.1	-4.95	0.4	0.17	1.88	0.08
4	0.1	-4.95	0.4	0.17	1.80	0.03
5	0.1	-4.95	0.4	0.17	1.77	0.00

```
6          0.1         -4.95              0.4        0.17         1.75
-0.03
  gyros_belt_z accel_belt_x accel_belt_y accel_belt_z magnet_belt_x magnet_be
lt_y
1          0.02          -3          -18           22           387
525
2          0.05          -2          -13           16           405
512
3          0.05          -2           -6            8           409
511
4          0.08          -6           -5            7           422
513
5          0.13          -4           -9            0           418
508
6          0.16           1           -9           -5           432
510
  magnet_belt_z roll_arm pitch_arm yaw_arm total_accel_arm var_accel_arm avg_
roll_arm
1          -267      132     -43.7   -53.6              38         65.0977
76.22175
2          -254      129     -45.3   -49.0              38         65.0977
76.22175
3          -244      125     -46.8   -43.7              35         65.0977
76.22175
4          -221      120     -48.1   -38.1              35         65.0977
76.22175
5          -208      115     -49.1   -31.7              34         65.0977
76.22175
6          -189      110     -49.6   -25.8              33         65.0977
76.22175
  stddev_roll_arm var_roll_arm avg_pitch_arm stddev_pitch_arm var_pitch_arm
1          16.1039      259.3599      -10.1695       10.66725      113.7978
2          16.1039      259.3599      -10.1695       10.66725      113.7978
3          16.1039      259.3599      -10.1695       10.66725      113.7978
4          16.1039      259.3599      -10.1695       10.66725      113.7978
5          16.1039      259.3599      -10.1695       10.66725      113.7978
6          16.1039      259.3599      -10.1695       10.66725      113.7978
  avg_yaw_arm stddev_yaw_arm var_yaw_arm gyros_arm_x gyros_arm_y gyros_arm_z
1    19.0615       35.8809     1287.463       2.65        -0.61       -0.02
2    19.0615       35.8809     1287.463       2.79        -0.64       -0.11
3    19.0615       35.8809     1287.463       2.91        -0.69       -0.15
4    19.0615       35.8809     1287.463       3.08        -0.72       -0.23
5    19.0615       35.8809     1287.463       3.20        -0.77       -0.25
6    19.0615       35.8809     1287.463       3.31        -0.83       -0.30
  accel_arm_x accel_arm_y accel_arm_z magnet_arm_x magnet_arm_y magnet_arm_z
1          143         30       -346          556         -205         -374
2          146         35       -339          599         -206         -335
3          156         44       -307          613         -198         -319
4          158         52       -305          646         -186         -268
5          163         55       -288          670         -175         -241
6          160         59       -274          696         -174         -193
  kurtosis_roll_arm kurtosis_picth_arm kurtosis_yaw_arm skewness_roll_arm
1         -1.18224          -0.96912         -0.86977           0.12353
2         -1.18224          -0.96912         -0.86977           0.12353
3         -1.18224          -0.96912         -0.86977           0.12353
4         -1.18224          -0.96912         -0.86977           0.12353
5         -1.18224          -0.96912         -0.86977           0.12353
```

```
6        -1.18224           -0.96912          -0.86977           0.12353
  skewness_pitch_arm skewness_yaw_arm max_roll_arm max_picth_arm max_yaw_arm
1         -0.10319          0.059765         8.45         77.25          38
2         -0.10319          0.059765         8.45         77.25          38
3         -0.10319          0.059765         8.45         77.25          38
4         -0.10319          0.059765         8.45         77.25          38
5         -0.10319          0.059765         8.45         77.25          38
6         -0.10319          0.059765         8.45         77.25          38
  min_roll_arm min_pitch_arm min_yaw_arm amplitude_roll_arm amplitude_pitch_a
rm
1        -33.6          -58.6           10             36.945                121
.5
2        -33.6          -58.6           10             36.945                121
.5
3        -33.6          -58.6           10             36.945                121
.5
4        -33.6          -58.6           10             36.945                121
.5
5        -33.6          -58.6           10             36.945                121
.5
6        -33.6          -58.6           10             36.945                121
.5
  amplitude_yaw_arm roll_dumbbell pitch_dumbbell yaw_dumbbell kurtosis_roll_d
umbbell
1               27      51.23554       11.698847    104.26473              -
0.09595
2               27      55.82442        9.645819    100.22805              -
0.09595
3               27      55.46983        6.875244    101.08411              -
0.09595
4               27      55.94486       11.079297     99.78456              -
0.09595
5               27      55.21174       11.426833    100.42258              -
0.09595
6               27      54.24731       14.126636    100.61574              -
0.09595
  kurtosis_picth_dumbbell skewness_roll_dumbbell skewness_pitch_dumbbell
1               -0.4422                 0.0819                 -0.216
2               -0.4422                 0.0819                 -0.216
3               -0.4422                 0.0819                 -0.216
4               -0.4422                 0.0819                 -0.216
5               -0.4422                 0.0819                 -0.216
6               -0.4422                 0.0819                 -0.216
  max_roll_dumbbell max_picth_dumbbell max_yaw_dumbbell min_roll_dumbbell
1        41.85              133              -0.1              -26.75
2        41.85              133              -0.1              -26.75
3        41.85              133              -0.1              -26.75
4        41.85              133              -0.1              -26.75
5        41.85              133              -0.1              -26.75
6        41.85              133              -0.1              -26.75
  min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dumbbell amplitude_pitch
_dumbbell
1           20.2             -0.1                  55.71
54.74
2           20.2             -0.1                  55.71
54.74
```

```
3                  20.2               -0.1                        55.71
54.74
4                  20.2               -0.1                        55.71
54.74
5                  20.2               -0.1                        55.71
54.74
6                  20.2               -0.1                        55.71
54.74
  amplitude_yaw_dumbbell total_accel_dumbbell var_accel_dumbbell avg_roll_dum
bbell
1                       0                    4           2.41635          -5.
11805
2                       0                    4           2.41635          -5.
11805
3                       0                    4           2.41635          -5.
11805
4                       0                    5           2.41635          -5.
11805
5                       0                    4           2.41635          -5.
11805
6                       0                    4           2.41635          -5.
11805
  stddev_roll_dumbbell var_roll_dumbbell avg_pitch_dumbbell stddev_pitch_dumb
bell
1               17.058           291.001            13.9312              14.
1062
2               17.058           291.001            13.9312              14.
1062
3               17.058           291.001            13.9312              14.
1062
4               17.058           291.001            13.9312              14.
1062
5               17.058           291.001            13.9312              14.
1062
6               17.058           291.001            13.9312              14.
1062
  var_pitch_dumbbell avg_yaw_dumbbell stddev_yaw_dumbbell var_yaw_dumbbell
1         199.0775          64.7063            13.5747          184.5578
2         199.0775          64.7063            13.5747          184.5578
3         199.0775          64.7063            13.5747          184.5578
4         199.0775          64.7063            13.5747          184.5578
5         199.0775          64.7063            13.5747          184.5578
6         199.0775          64.7063            13.5747          184.5578
  gyros_dumbbell_x gyros_dumbbell_y gyros_dumbbell_z accel_dumbbell_x accel_d
umbbell_y
1            -0.31             0.16             0.08                5
21
2            -0.31             0.14             0.07                4
22
3            -0.31             0.16             0.05                3
23
4            -0.31             0.16             0.07                5
24
5            -0.31             0.14             0.07                5
23
6            -0.31             0.14             0.07                6
22
```

```
   accel_dumbbell_z magnet_dumbbell_x magnet_dumbbell_y magnet_dumbbell_z roll
_forearm
1                37              -471              191              277
-111
2                35              -472              184              281
-112
3                37              -468              190              275
-114
4                38              -469              184              285
-115
5                37              -468              189              292
-117
6                36              -473              188              278
-118
  pitch_forearm yaw_forearm kurtosis_roll_forearm kurtosis_picth_forearm
1         26.5         138              -1.09475                -0.97525
2         26.2         138              -1.09475                -0.97525
3         26.0         137              -1.09475                -0.97525
4         25.8         137              -1.09475                -0.97525
5         25.5         137              -1.09475                -0.97525
6         25.1         137              -1.09475                -0.97525
  skewness_roll_forearm skewness_pitch_forearm max_roll_forearm max_picth_for
earm
1              -0.05065                0.17285             49.6
168
2              -0.05065                0.17285             49.6
168
3              -0.05065                0.17285             49.6
168
4              -0.05065                0.17285             49.6
168
5              -0.05065                0.17285             49.6
168
6              -0.05065                0.17285             49.6
168
  max_yaw_forearm min_roll_forearm min_pitch_forearm min_yaw_forearm
1            -1.1             4.65             -168.5            -1.1
2            -1.1             4.65             -168.5            -1.1
3            -1.1             4.65             -168.5            -1.1
4            -1.1             4.65             -168.5            -1.1
5            -1.1             4.65             -168.5            -1.1
6            -1.1             4.65             -168.5            -1.1
  amplitude_roll_forearm amplitude_pitch_forearm amplitude_yaw_forearm
1                  32.2                   341.5                     0
2                  32.2                   341.5                     0
3                  32.2                   341.5                     0
4                  32.2                   341.5                     0
5                  32.2                   341.5                     0
6                  32.2                   341.5                     0
  total_accel_forearm var_accel_forearm avg_roll_forearm stddev_roll_forearm
1                  30           14.0772         27.85936            45.16342
2                  31           14.0772         27.85936            45.16342
3                  32           14.0772         27.85936            45.16342
4                  33           14.0772         27.85936            45.16342
5                  34           14.0772         27.85936            45.16342
6                  36           14.0772         27.85936            45.16342
  var_roll_forearm avg_pitch_forearm stddev_pitch_forearm var_pitch_forearm
```

1	2749.163	25.35597	8.906695	79.33451
2	2749.163	25.35597	8.906695	79.33451
3	2749.163	25.35597	8.906695	79.33451
4	2749.163	25.35597	8.906695	79.33451
5	2749.163	25.35597	8.906695	79.33451
6	2749.163	25.35597	8.906695	79.33451

	avg_yaw_forearm	stddev_yaw_forearm	var_yaw_forearm	gyros_forearm_x	gyros_forearm_y
1	17.09505	74.27584	5541.956	-0.05	-0.37
2	17.09505	74.27584	5541.956	-0.06	-0.37
3	17.09505	74.27584	5541.956	-0.05	-0.27
4	17.09505	74.27584	5541.956	0.02	-0.24
5	17.09505	74.27584	5541.956	0.08	-0.27
6	17.09505	74.27584	5541.956	0.14	-0.29

	gyros_forearm_z	accel_forearm_x	accel_forearm_y	accel_forearm_z	magnet_forearm_x
1	-0.43	-170	155	184	-1160
2	-0.59	-178	164	182	-1150
3	-0.72	-182	172	185	-1130
4	-0.79	-185	182	188	-1120
5	-0.82	-188	195	188	-1100
6	-0.82	-208	207	190	-1090

	magnet_forearm_y	magnet_forearm_z	accel_forearm_y.1	accel_forearm_z.1
1	1400	-876	155	184
2	1410	-871	164	182
3	1400	-863	172	185
4	1400	-855	182	188
5	1400	-843	195	188
6	1400	-838	207	190

	magnet_forearm_x.1	magnet_forearm_y.1	magnet_forearm_z.1	classe
1	-1160	1400	-876	E
2	-1150	1410	-871	E
3	-1130	1400	-863	E
4	-1120	1400	-855	E
5	-1100	1400	-843	E
6	-1090	1400	-838	E

```
> head(dataTest)
```

	user_name	raw_timestamp_part_1	raw_timestamp_part_2	cvtd_timestamp	new_window
4005	pedro	1323095020	504350	5/12/2011 14:23	no
4006	pedro	1323095020	504423	5/12/2011 14:23	no
4007	pedro	1323095020	504460	5/12/2011 14:23	no

4008	pedro	1323095020		532277	5/12/2011 14:23
no					
4009	pedro	1323095020		532302	5/12/2011 14:23
no					
4010	pedro	1323095020		572363	5/12/2011 14:23
no					

	num_window	roll_belt	pitch_belt	yaw_belt	total_accel_belt	kurtosis_roll_belt
4005	91	122	25.9	-3.54	19	-1.0
3566						
4006	91	122	25.9	-3.48	19	-1.0
3566						
4007	91	122	25.8	-3.39	19	-1.0
3566						
4008	91	122	25.8	-3.33	19	-1.0
3566						
4009	91	122	25.8	-3.30	19	-1.0
3566						
4010	91	122	25.8	-3.29	19	-1.0
3566						

	kurtosis_picth_belt	skewness_roll_belt	skewness_roll_belt.1	max_roll_belt
4005	-0.39133	0.005406	0.045115	-4.
1				
4006	-0.39133	0.005406	0.045115	-4.
1				
4007	-0.39133	0.005406	0.045115	-4.
1				
4008	-0.39133	0.005406	0.045115	-4.
1				
4009	-0.39133	0.005406	0.045115	-4.
1				
4010	-0.39133	0.005406	0.045115	-4.
1				

	max_picth_belt	max_yaw_belt	min_roll_belt	min_pitch_belt	min_yaw_belt
4005	20	-1	-7.25	18	-1
4006	20	-1	-7.25	18	-1
4007	20	-1	-7.25	18	-1
4008	20	-1	-7.25	18	-1
4009	20	-1	-7.25	18	-1
4010	20	-1	-7.25	18	-1

	amplitude_roll_belt	amplitude_pitch_belt	amplitude_yaw_belt	var_total_accel_belt
4005	1.345	2	0	
0.3				
4006	1.345	2	0	
0.3				
4007	1.345	2	0	
0.3				
4008	1.345	2	0	
0.3				
4009	1.345	2	0	
0.3				
4010	1.345	2	0	
0.3				

	avg_roll_belt	stddev_roll_belt	var_roll_belt	avg_pitch_belt	stddev_pitch_belt

4005	121.9	0.6	0.35	25.75	
0.35					
4006	121.9	0.6	0.35	25.75	
0.35					
4007	121.9	0.6	0.35	25.75	
0.35					
4008	121.9	0.6	0.35	25.75	
0.35					
4009	121.9	0.6	0.35	25.75	
0.35					
4010	121.9	0.6	0.35	25.75	
0.35					

	var_pitch_belt	avg_yaw_belt	stddev_yaw_belt	var_yaw_belt	gyros_belt_x
4005	0.1	-4.95	0.4	0.17	-0.39
4006	0.1	-4.95	0.4	0.17	-0.39
4007	0.1	-4.95	0.4	0.17	-0.37
4008	0.1	-4.95	0.4	0.17	-0.39
4009	0.1	-4.95	0.4	0.17	-0.39
4010	0.1	-4.95	0.4	0.17	-0.40

	gyros_belt_y	gyros_belt_z	accel_belt_x	accel_belt_y	accel_belt_z	magnet_belt_x
4005	-0.03	-0.48	-39	71	-170	
-1						
4006	-0.03	-0.46	-39	69	-172	
1						
4007	-0.03	-0.46	-40	68	-170	
-4						
4008	-0.03	-0.46	-42	69	-167	
-6						
4009	-0.03	-0.46	-42	70	-168	
-6						
4010	-0.03	-0.46	-42	72	-171	
-4						

	magnet_belt_y	magnet_belt_z	roll_arm	pitch_arm	yaw_arm	total_accel_arm
4005	582	-356	83.0	23.1	47.1	23
4006	587	-358	81.6	22.1	44.5	25
4007	586	-362	80.2	21.0	41.9	24
4008	589	-366	78.9	20.0	39.4	26
4009	590	-368	77.6	18.9	36.7	27
4010	591	-354	76.5	17.7	34.0	28

	var_accel_arm	avg_roll_arm	stddev_roll_arm	var_roll_arm	avg_pitch_arm
4005	65.0977	76.22175	16.1039	259.3599	-10.1695
4006	65.0977	76.22175	16.1039	259.3599	-10.1695
4007	65.0977	76.22175	16.1039	259.3599	-10.1695
4008	65.0977	76.22175	16.1039	259.3599	-10.1695
4009	65.0977	76.22175	16.1039	259.3599	-10.1695
4010	65.0977	76.22175	16.1039	259.3599	-10.1695

	stddev_pitch_arm	var_pitch_arm	avg_yaw_arm	stddev_yaw_arm	var_yaw_arm	gyros_arm_x
4005	10.66725	113.7978	19.0615	35.8809	1287.463	
-2.06						
4006	10.66725	113.7978	19.0615	35.8809	1287.463	
-2.06						
4007	10.66725	113.7978	19.0615	35.8809	1287.463	
-2.07						
4008	10.66725	113.7978	19.0615	35.8809	1287.463	
-2.14						

```
4009          10.66725        113.7978      19.0615        35.8809      1287.463
-2.14
4010          10.66725        113.7978      19.0615        35.8809      1287.463
-2.12
     gyros_arm_y gyros_arm_z accel_arm_x accel_arm_y accel_arm_z magnet_arm_x
4005         0.55        -0.26         182          28          138          342
4006         0.56        -0.31         196          23          148          370
4007         0.51        -0.33         193          18          140          388
4008         0.48        -0.31         207          21          140          432
4009         0.43        -0.28         226          12          140          448
4010         0.37        -0.20         235           9          143          482
     magnet_arm_y magnet_arm_z kurtosis_roll_arm kurtosis_picth_arm kurtosis_
yaw_arm
4005         280          503          -1.18224          -0.96912          -
0.86977
4006         263          485          -1.18224          -0.96912          -
0.86977
4007         261          486          -1.18224          -0.96912          -
0.86977
4008         249          472          -1.18224          -0.96912          -
0.86977
4009         239          454          -1.18224          -0.96912          -
0.86977
4010         225          437          -1.18224          -0.96912          -
0.86977
     skewness_roll_arm skewness_pitch_arm skewness_yaw_arm max_roll_arm max_p
icth_arm
4005          0.12353          -0.10319          0.059765          8.45
77.25
4006          0.12353          -0.10319          0.059765          8.45
77.25
4007          0.12353          -0.10319          0.059765          8.45
77.25
4008          0.12353          -0.10319          0.059765          8.45
77.25
4009          0.12353          -0.10319          0.059765          8.45
77.25
4010          0.12353          -0.10319          0.059765          8.45
77.25
     max_yaw_arm min_roll_arm min_pitch_arm min_yaw_arm amplitude_roll_arm
4005          38         -33.6          -58.6          10          36.945
4006          38         -33.6          -58.6          10          36.945
4007          38         -33.6          -58.6          10          36.945
4008          38         -33.6          -58.6          10          36.945
4009          38         -33.6          -58.6          10          36.945
4010          38         -33.6          -58.6          10          36.945
     amplitude_pitch_arm amplitude_yaw_arm roll_dumbbell pitch_dumbbell yaw_d
umbbell
4005          121.5          27      -64.335693       34.112879       8
1.36272
4006          121.5          27      -40.195925       53.186300       8
7.56417
4007          121.5          27       -2.792178       62.646067       9
4.35153
4008          121.5          27       10.384733       49.182165      10
6.61750
```

```
4009              121.5              27    16.647582     22.278218    12
9.09792
4010              121.5              27   -14.860425      6.172999    14
0.97044
     kurtosis_roll_dumbbell kurtosis_picth_dumbbell skewness_roll_dumbbell
4005                -0.09595                -0.4422                 0.0819
4006                -0.09595                -0.4422                 0.0819
4007                -0.09595                -0.4422                 0.0819
4008                -0.09595                -0.4422                 0.0819
4009                -0.09595                -0.4422                 0.0819
4010                -0.09595                -0.4422                 0.0819
     skewness_pitch_dumbbell max_roll_dumbbell max_picth_dumbbell max_yaw_dum
bbell
4005                  -0.216             41.85                133
-0.1
4006                  -0.216             41.85                133
-0.1
4007                  -0.216             41.85                133
-0.1
4008                  -0.216             41.85                133
-0.1
4009                  -0.216             41.85                133
-0.1
4010                  -0.216             41.85                133
-0.1
    min_roll_dumbbell min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dum
bbell
4005             -26.75               20.2             -0.1
55.71
4006             -26.75               20.2             -0.1
55.71
4007             -26.75               20.2             -0.1
55.71
4008             -26.75               20.2             -0.1
55.71
4009             -26.75               20.2             -0.1
55.71
4010             -26.75               20.2             -0.1
55.71
    amplitude_pitch_dumbbell amplitude_yaw_dumbbell total_accel_dumbbell
4005                    54.74                     0                    9
4006                    54.74                     0                    7
4007                    54.74                     0                    7
4008                    54.74                     0                    9
4009                    54.74                     0                    9
4010                    54.74                     0                    8
    var_accel_dumbbell avg_roll_dumbbell stddev_roll_dumbbell var_roll_dumbb
ell
4005            2.41635          -5.11805               17.058           291.
001
4006            2.41635          -5.11805               17.058           291.
001
4007            2.41635          -5.11805               17.058           291.
001
4008            2.41635          -5.11805               17.058           291.
001
```

4009	2.41635	-5.11805	17.058	291.
001				
4010	2.41635	-5.11805	17.058	291.
001				

	avg_pitch_dumbbell	stddev_pitch_dumbbell	var_pitch_dumbbell	avg_yaw_dumb
bell				
4005	13.9312	14.1062	199.0775	64.
7063				
4006	13.9312	14.1062	199.0775	64.
7063				
4007	13.9312	14.1062	199.0775	64.
7063				
4008	13.9312	14.1062	199.0775	64.
7063				
4009	13.9312	14.1062	199.0775	64.
7063				
4010	13.9312	14.1062	199.0775	64.
7063				

	stddev_yaw_dumbbell	var_yaw_dumbbell	gyros_dumbbell_x	gyros_dumbbell_y
4005	13.5747	184.5578	0.16	-0.75
4006	13.5747	184.5578	0.08	-0.79
4007	13.5747	184.5578	0.03	-0.87
4008	13.5747	184.5578	-0.02	-0.92
4009	13.5747	184.5578	-0.02	-0.85
4010	13.5747	184.5578	0.00	-0.63

	gyros_dumbbell_z	accel_dumbbell_x	accel_dumbbell_y	accel_dumbbell_z
4005	0.39	29	-52	63
4006	0.15	35	-27	53
4007	-0.02	42	-2	58
4008	0.11	41	9	76
4009	0.33	20	15	87
4010	0.51	5	-12	80

	magnet_dumbbell_x	magnet_dumbbell_y	magnet_dumbbell_z	roll_forearm	pitch
_forearm					
4005	494	-550	-105	141	
40.9					
4006	501	-554	-91	142	
38.1					
4007	514	-539	-104	142	
34.3					
4008	515	-533	-108	142	
31.4					
4009	526	-525	-98	141	
29.2					
4010	537	-517	-108	141	
27.0					

	yaw_forearm	kurtosis_roll_forearm	kurtosis_picth_forearm	skewness_roll_f
orearm				
4005	147	-1.09475	-0.97525	-0
.05065				
4006	143	-1.09475	-0.97525	-0
.05065				
4007	137	-1.09475	-0.97525	-0
.05065				
4008	132	-1.09475	-0.97525	-0
.05065				

4009	128	-1.09475	-0.97525	-0.05065
4010	123	-1.09475	-0.97525	-0.05065

	skewness_pitch_forearm	max_roll_forearm	max_picth_forearm	max_yaw_forearm
4005	0.17285	49.6	168	-1.1
4006	0.17285	49.6	168	-1.1
4007	0.17285	49.6	168	-1.1
4008	0.17285	49.6	168	-1.1
4009	0.17285	49.6	168	-1.1
4010	0.17285	49.6	168	-1.1

	min_roll_forearm	min_pitch_forearm	min_yaw_forearm	amplitude_roll_forearm
4005	4.65	-168.5	-1.1	32.2
4006	4.65	-168.5	-1.1	32.2
4007	4.65	-168.5	-1.1	32.2
4008	4.65	-168.5	-1.1	32.2
4009	4.65	-168.5	-1.1	32.2
4010	4.65	-168.5	-1.1	32.2

	amplitude_pitch_forearm	amplitude_yaw_forearm	total_accel_forearm
4005	341.5	0	29
4006	341.5	0	40
4007	341.5	0	39
4008	341.5	0	39
4009	341.5	0	39
4010	341.5	0	38

	var_accel_forearm	avg_roll_forearm	stddev_roll_forearm	var_roll_forearm
4005	14.0772	27.85936	45.16342	2749.163
4006	14.0772	27.85936	45.16342	2749.163
4007	14.0772	27.85936	45.16342	2749.163
4008	14.0772	27.85936	45.16342	2749.163
4009	14.0772	27.85936	45.16342	2749.163
4010	14.0772	27.85936	45.16342	2749.163

	avg_pitch_forearm	stddev_pitch_forearm	var_pitch_forearm	avg_yaw_forearm
4005	25.35597	8.906695	79.33451	17.09505
4006	25.35597	8.906695	79.33451	17.09505
4007	25.35597	8.906695	79.33451	17.09505
4008	25.35597	8.906695	79.33451	17.09505
4009	25.35597	8.906695	79.33451	17.09505
4010	25.35597	8.906695	79.33451	17.09505

	stddev_yaw_forearm	var_yaw_forearm	gyros_forearm_x	gyros_forearm_y
4005	74.27584	5541.956	0.16	3.48
4006	74.27584	5541.956	0.11	3.36
4007	74.27584	5541.956	0.21	4.38

4008	74.27584	5541.956	0.02	3.77
4009	74.27584	5541.956	-0.35	3.21
4010	74.27584	5541.956	-0.69	3.58

	gyros_forearm_z	accel_forearm_x	accel_forearm_y	accel_forearm_z	magnet_forearm_x
4005	3.08	12	269	-98	-704
4006	2.76	-51	353	-158	-706
4007	2.03	33	357	-122	-700
4008	1.74	9	359	-125	-684
4009	1.44	-9	352	-143	-673
4010	1.07	-44	335	-153	-652

	magnet_forearm_y	magnet_forearm_z	accel_forearm_y.1	accel_forearm_z.1
4005	398	921	269	-98
4006	484	923	353	-158
4007	524	921	357	-122
4008	589	923	359	-125
4009	619	935	352	-143
4010	672	947	335	-153

	magnet_forearm_x.1	magnet_forearm_y.1	magnet_forearm_z.1	classe
4005	-704	398	921	C
4006	-706	484	923	C
4007	-700	524	921	C
4008	-684	589	923	C
4009	-673	619	935	C
4010	-652	672	947	C

```
> indexNA <- as.vector(sapply(dataTrain[,1:158],function(x) {length(which(is.
na(x)))!=0}))
> dataTrain <- dataTrain[,!indexNA]
> train_control<- trainControl(method="cv", number=10)
>
> model<- train(classe ~., data=dataTrain,trControl=train_control, method="rf
")
> model
Random Forest

4004 samples
 157 predictor
   5 classes: 'A', 'B', 'C', 'D', 'E'

No pre-processing
Resampling: Cross-Validated (10 fold)
Summary of sample sizes: 3604, 3604, 3604, 3604, 3603, 3603, ...
Resampling results across tuning parameters:

  mtry  Accuracy   Kappa
    2   0.9730274  0.9617679
   83   1.0000000  1.0000000
  165   0.9990006  0.9985890
```

```
Accuracy was used to select the optimal model using the largest value.
The final value used for the model was mtry = 83.
> # make predictions
> predictions<- predict(model,dataTrain)
> # append predictions
> pred<- cbind(dataTrain,predictions)
> # summarize results
> confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)
> confusionMatrix
Confusion Matrix and Statistics

          Reference
Prediction    A    B    C    D    E
        A 1365    0    0    0    0
        B    0  901    0    0    0
        C    0    0   92    0    0
        D    0    0    0  276    0
        E    0    0    0    0 1370

Overall Statistics

               Accuracy : 1
                 95% CI : (0.9991, 1)
    No Information Rate : 0.3422
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 1
 Mcnemar's Test P-Value : NA

Statistics by Class:

                     Class: A Class: B Class: C Class: D Class: E
Sensitivity            1.0000    1.000  1.00000  1.00000   1.0000
Specificity            1.0000    1.000  1.00000  1.00000   1.0000
Pos Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Neg Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Prevalence             0.3409    0.225  0.02298  0.06893   0.3422
Detection Rate         0.3409    0.225  0.02298  0.06893   0.3422
Detection Prevalence   0.3409    0.225  0.02298  0.06893   0.3422
Balanced Accuracy      1.0000    1.000  1.00000  1.00000   1.0000
> #how do we create a cross validation scheme
> control <- trainControl(method = 'repeatedcv',
+                         number = 10,
+                         repeats = 3)
> seed <-7
> metric <- 'Accuracy'
> set.seed(seed)
> mtry <- sqrt(ncol(dataTrain))
> tunegrid <- expand.grid(.mtry=mtry)
> rf_default <- train(pitch_belt~.,
+                     data = dataTrain,
+                     method = 'rf',
+                     metric = 0,
+                     tuneGrid = tunegrid,
+                     trControl = control)
Warning message:
In train.default(x, y, weights = w, ...) :
```

```
   The metric "0" was not in the result set. RMSE will be used instead.
> print(rf_default)
Random Forest

4004 samples
 157 predictor

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 3 times)
Summary of sample sizes: 3602, 3603, 3603, 3603, 3605, 3604, ...
Resampling results:

  RMSE       Rsquared   MAE
  0.3719505  0.9996205  0.1836054

Tuning parameter 'mtry' was held constant at a value of 12.56981
> #------------------------------
>
> # make predictions
> predictions<- predict(rf_default,dataTest)
> # append predictions
> pred<- cbind(dataTest,predictions)
> # summarize results
> confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)
Error: `data` and `reference` should be factors with the same levels.
> confusionMatrix
Confusion Matrix and Statistics

          Reference
Prediction    A    B    C    D    E
         A 1365    0    0    0    0
         B    0  901    0    0    0
         C    0    0   92    0    0
         D    0    0    0  276    0
         E    0    0    0    0 1370

Overall Statistics

               Accuracy : 1
                 95% CI : (0.9991, 1)
    No Information Rate : 0.3422
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 1
 Mcnemar's Test P-Value : NA

Statistics by Class:
```

	Class: A	Class: B	Class: C	Class: D	Class: E
Sensitivity	1.0000	1.000	1.00000	1.00000	1.0000
Specificity	1.0000	1.000	1.00000	1.00000	1.0000
Pos Pred Value	1.0000	1.000	1.00000	1.00000	1.0000
Neg Pred Value	1.0000	1.000	1.00000	1.00000	1.0000
Prevalence	0.3409	0.225	0.02298	0.06893	0.3422
Detection Rate	0.3409	0.225	0.02298	0.06893	0.3422
Detection Prevalence	0.3409	0.225	0.02298	0.06893	0.3422
Balanced Accuracy	1.0000	1.000	1.00000	1.00000	1.0000

```
> varImp(rf_default)
Error in varImp[, "%IncMSE"] : subscript out of bounds
Called from: data.frame(Overall = varImp[, "%IncMSE"])
Browse[1]> #----------------
Browse[1]> # random search for parameters
Browse[1]> control <- trainControl(method = 'repeatedcv',
+                          number = 10,
+                          repeats = 3,
+                          search = 'random')
Browse[1]> # make predictions
Browse[1]> predictions<- predict(rf_default,dataTest)
Browse[1]>
> # append predictions
> pred<- cbind(dataTest,predictions)
>
> # summarize results
> confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)
Error: `data` and `reference` should be factors with the same levels.
> confusionMatrix
Confusion Matrix and Statistics

          Reference
Prediction    A    B    C    D    E
         A 1365    0    0    0    0
         B    0  901    0    0    0
         C    0    0   92    0    0
         D    0    0    0  276    0
         E    0    0    0    0 1370

Overall Statistics

               Accuracy : 1
                 95% CI : (0.9991, 1)
    No Information Rate : 0.3422
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 1
 Mcnemar's Test P-Value : NA

Statistics by Class:

                     Class: A Class: B Class: C Class: D Class: E
Sensitivity            1.0000    1.000  1.00000  1.00000   1.0000
Specificity            1.0000    1.000  1.00000  1.00000   1.0000
Pos Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Neg Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Prevalence             0.3409    0.225  0.02298  0.06893   0.3422
Detection Rate         0.3409    0.225  0.02298  0.06893   0.3422
Detection Prevalence   0.3409    0.225  0.02298  0.06893   0.3422
Balanced Accuracy      1.0000    1.000  1.00000  1.00000   1.0000
> varImp(random)
Error in varImp(random) : object 'random' not found
> #--------------------
> #----------------------------------------------------------------
> # Grid search
> control <- trainControl(method = 'repeatedcv',
+                          number = 10,
```

```
+                               repeats = 3,
+                               search = 'grid')
> set.seed(seed)
> tunegrid <- expand.grid(.mtry=c(1:80))
> #mtry <- sqrt(ncol(x))
> rf_gridsearch <- train(~.,
+                       data = dataTrain[1:200,],
+                       method = 'rf',
+                       metric = metric,
+                       tuneGrid = tunegrid,
+                       trControl = control)
Error: Please make sure `y` is a factor or numeric value.
> print(rf_gridsearch)
Error in print(rf_gridsearch) : object 'rf_gridsearch' not found
> plot(rf_gridsearch)
Error in plot(rf_gridsearch) : object 'rf_gridsearch' not found
> # make predictions
> predictions<- predict(rf_gridsearch,dataTest)
Error in predict(rf_gridsearch, dataTest) :
  object 'rf_gridsearch' not found
>
> # append predictions
> pred<- cbind(dataTest,predictions)
>
> # summarize results
> confusionMatrix<- confusionMatrix(pred$predictions,pred$pitch_belt)
Error: `data` and `reference` should be factors with the same levels.
> confusionMatrix
Confusion Matrix and Statistics

          Reference
Prediction    A    B    C    D    E
         A 1365    0    0    0    0
         B    0  901    0    0    0
         C    0    0   92    0    0
         D    0    0    0  276    0
         E    0    0    0    0 1370

Overall Statistics

               Accuracy : 1
                 95% CI : (0.9991, 1)
    No Information Rate : 0.3422
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 1
 Mcnemar's Test P-Value : NA

Statistics by Class:

                     Class: A Class: B Class: C Class: D Class: E
Sensitivity            1.0000    1.000  1.00000  1.00000   1.0000
Specificity            1.0000    1.000  1.00000  1.00000   1.0000
Pos Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Neg Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Prevalence             0.3409    0.225  0.02298  0.06893   0.3422
Detection Rate         0.3409    0.225  0.02298  0.06893   0.3422
```

```
Detection Prevalence    0.3409    0.225  0.02298  0.06893   0.3422
Balanced Accuracy       1.0000    1.000  1.00000  1.00000   1.0000
> varImp(rf_gridsearch)
Error in varImp(rf_gridsearch) : object 'rf_gridsearch' not found
>
> ---------------------------
+   # Boosting
+   # --------------------------------------
+ # Boosting model requires three things
+
+ #1- a loss function to be optimized
+ #2- a weak learner to make predictions
+ #3- an additive model to add the weak learners to minimize the loss functio
n
+
+ # gradient boosting
+ control <- trainControl(method = 'repeatedcv',
+                         number = 5,
+                         repeats = 3,
+                         search = 'grid')
Error in -`*tmp*` : invalid argument to unary operator
>
> seed <- 7
> library(C50)
> set.seed(seed)
> metric <- 'Accuracy'
> gbm_mod <- train(pitch_belt~.,
+                  data = dataTrain,
+                  method = 'gbm',
+                  metric = 0,
+                  trControl = control)
Iter   TrainDeviance   ValidDeviance   StepSize   Improve
     1      290.4643            nan     0.1000   66.8385
     2      240.0107            nan     0.1000   49.7536
     3      199.7165            nan     0.1000   39.9944
     4      166.7692            nan     0.1000   31.6237
     5      138.7180            nan     0.1000   27.8200
     6      117.1658            nan     0.1000   21.8218
     7       99.0041            nan     0.1000   17.7844
     8       84.2149            nan     0.1000   13.7951
     9       71.1916            nan     0.1000   12.5779
    10       60.7509            nan     0.1000   10.4406
    20       16.9581            nan     0.1000    2.0061
    40        4.0588            nan     0.1000    0.1219
    60        2.5921            nan     0.1000    0.0084
    80        2.1022            nan     0.1000   -0.0069
   100        1.7142            nan     0.1000   -0.0182
   120        1.5353            nan     0.1000   -0.0081
   140        1.2641            nan     0.1000    0.0052
   150        1.2063            nan     0.1000    0.0001

Warning messages:
1: In train.default(x, y, weights = w, ...) :
  The metric "0" was not in the result set. RMSE will be used instead.
2: In (function (x, y, offset = NULL, misc = NULL, distribution = "bernoulli"
, :
  variable 30: amplitude_yaw_belt has no variation.
```

```
3: In (function (x, y, offset = NULL, misc = NULL, distribution = "bernoulli"
, :
  variable 103: amplitude_yaw_dumbbell has no variation.
4: In (function (x, y, offset = NULL, misc = NULL, distribution = "bernoulli"
, :
  variable 139: amplitude_yaw_forearm has no variation.
> print(gbm_mod)
Stochastic Gradient Boosting

4004 samples
 157 predictor

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 3 times)
Summary of sample sizes: 3602, 3603, 3603, 3603, 3605, 3604, ...
Resampling results across tuning parameters:

  interaction.depth  n.trees  RMSE      Rsquared   MAE
  1                   50      3.870491  0.9708972  2.0739488
  1                  100      2.518277  0.9818947  1.1065126
  1                  150      2.258849  0.9850289  0.9958785
  2                   50      2.183970  0.9866430  1.0364026
  2                  100      1.662759  0.9916854  0.8202113
  2                  150      1.485456  0.9934375  0.7464795
  3                   50      1.950370  0.9886048  0.9201246
  3                  100      1.529421  0.9928336  0.7607945
  3                  150      1.330676  0.9946265  0.6793264

Tuning parameter 'shrinkage' was held constant at a value of 0.1
Tuning
 parameter 'n.minobsinnode' was held constant at a value of 10
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were n.trees = 150, interaction.depth =
 3, shrinkage = 0.1 and n.minobsinnode = 10.
> plot(gbm_mod)
>
> summary(gbm_mod)
                                               var       rel.inf
accel_belt_x                           accel_belt_x 5.294894e+01
user_namecarlitos                 user_namecarlitos 2.264130e+01
yaw_belt                                   yaw_belt 1.009582e+01
magnet_belt_z                         magnet_belt_z 3.195192e+00
roll_belt                                 roll_belt 2.097407e+00
magnet_belt_x                         magnet_belt_x 1.915681e+00
magnet_belt_y                         magnet_belt_y 1.262021e+00
user_nameeurico                     user_nameeurico 9.356612e-01
accel_forearm_z                     accel_forearm_z 8.031061e-01
yaw_dumbbell                           yaw_dumbbell 6.542763e-01
magnet_dumbbell_z                 magnet_dumbbell_z 5.525906e-01
roll_arm                                   roll_arm 4.706543e-01
magnet_forearm_y                   magnet_forearm_y 4.194178e-01
raw_timestamp_part_1           raw_timestamp_part_1 4.174086e-01
accel_dumbbell_y                   accel_dumbbell_y 3.929518e-01
total_accel_belt                   total_accel_belt 2.065530e-01
classeE                                     classeE 1.635014e-01
gyros_belt_x                           gyros_belt_x 7.771816e-02
gyros_belt_z                           gyros_belt_z 7.088366e-02
```

```
magnet_forearm_z                  magnet_forearm_z 6.476310e-02
gyros_dumbbell_z                  gyros_dumbbell_z 6.476114e-02
magnet_dumbbell_y                 magnet_dumbbell_y 6.082279e-02
accel_arm_y                            accel_arm_y 4.211095e-02
magnet_forearm_x                  magnet_forearm_x 3.649721e-02
gyros_arm_x                            gyros_arm_x 3.524758e-02
raw_timestamp_part_2          raw_timestamp_part_2 3.187452e-02
magnet_arm_y                          magnet_arm_y 2.913115e-02
roll_forearm                          roll_forearm 2.691063e-02
accel_belt_y                          accel_belt_y 2.612166e-02
gyros_belt_y                          gyros_belt_y 2.610858e-02
accel_forearm_x                    accel_forearm_x 2.591538e-02
yaw_forearm                            yaw_forearm 2.342590e-02
magnet_arm_x                          magnet_arm_x 2.176473e-02
roll_dumbbell                        roll_dumbbell 1.994693e-02
gyros_dumbbell_y                  gyros_dumbbell_y 1.606333e-02
accel_dumbbell_z                  accel_dumbbell_z 1.393099e-02
accel_arm_z                            accel_arm_z 1.171088e-02
pitch_forearm                        pitch_forearm 1.000282e-02
magnet_dumbbell_x                 magnet_dumbbell_x 9.832274e-03
gyros_arm_z                            gyros_arm_z 9.797342e-03
gyros_forearm_y                    gyros_forearm_y 8.829820e-03
yaw_arm                                    yaw_arm 8.821700e-03
accel_belt_z                          accel_belt_z 6.208694e-03
cvtd_timestamp5/12/2011 14:22    cvtd_timestamp5/12/2011 14:22 6.063530e-03
accel_dumbbell_x                  accel_dumbbell_x 5.853397e-03
accel_arm_x                            accel_arm_x 5.649238e-03
total_accel_dumbbell          total_accel_dumbbell 4.196944e-03
gyros_forearm_z                    gyros_forearm_z 4.185309e-03
accel_forearm_y                    accel_forearm_y 3.517185e-03
pitch_dumbbell                      pitch_dumbbell 3.131461e-03
gyros_forearm_x                    gyros_forearm_x 2.607342e-03
gyros_arm_y                            gyros_arm_y 2.402347e-03
total_accel_arm                    total_accel_arm 2.323679e-03
total_accel_forearm            total_accel_forearm 1.821801e-03
gyros_dumbbell_x                  gyros_dumbbell_x 1.812110e-03
pitch_arm                                pitch_arm 1.803214e-03
min_pitch_forearm              min_pitch_forearm 1.147246e-03
var_yaw_belt                          var_yaw_belt 1.011198e-03
magnet_arm_z                          magnet_arm_z 7.885704e-04
user_namejeremy                    user_namejeremy 0.000000e+00
user_namepedro                      user_namepedro 0.000000e+00
cvtd_timestamp28/11/2011 14:15  cvtd_timestamp28/11/2011 14:15 0.000000e+00
cvtd_timestamp30/11/2011 17:12  cvtd_timestamp30/11/2011 17:12 0.000000e+00
cvtd_timestamp5/12/2011 11:23    cvtd_timestamp5/12/2011 11:23 0.000000e+00
cvtd_timestamp5/12/2011 11:25    cvtd_timestamp5/12/2011 11:25 0.000000e+00
cvtd_timestamp5/12/2011 14:23    cvtd_timestamp5/12/2011 14:23 0.000000e+00
new_windowyes                        new_windowyes 0.000000e+00
num_window                              num_window 0.000000e+00
kurtosis_roll_belt              kurtosis_roll_belt 0.000000e+00
kurtosis_picth_belt            kurtosis_picth_belt 0.000000e+00
skewness_roll_belt              skewness_roll_belt 0.000000e+00
skewness_roll_belt.1          skewness_roll_belt.1 0.000000e+00
max_roll_belt                        max_roll_belt 0.000000e+00
max_picth_belt                      max_picth_belt 0.000000e+00
max_yaw_belt                          max_yaw_belt 0.000000e+00
min_roll_belt                        min_roll_belt 0.000000e+00
```

```
min_pitch_belt                               min_pitch_belt 0.000000e+00
min_yaw_belt                                   min_yaw_belt 0.000000e+00
amplitude_roll_belt                     amplitude_roll_belt 0.000000e+00
amplitude_pitch_belt                   amplitude_pitch_belt 0.000000e+00
amplitude_yaw_belt                       amplitude_yaw_belt 0.000000e+00
var_total_accel_belt                   var_total_accel_belt 0.000000e+00
avg_roll_belt                                 avg_roll_belt 0.000000e+00
stddev_roll_belt                           stddev_roll_belt 0.000000e+00
var_roll_belt                                 var_roll_belt 0.000000e+00
avg_pitch_belt                               avg_pitch_belt 0.000000e+00
stddev_pitch_belt                         stddev_pitch_belt 0.000000e+00
var_pitch_belt                               var_pitch_belt 0.000000e+00
avg_yaw_belt                                   avg_yaw_belt 0.000000e+00
stddev_yaw_belt                             stddev_yaw_belt 0.000000e+00
var_accel_arm                                 var_accel_arm 0.000000e+00
avg_roll_arm                                   avg_roll_arm 0.000000e+00
stddev_roll_arm                             stddev_roll_arm 0.000000e+00
var_roll_arm                                   var_roll_arm 0.000000e+00
avg_pitch_arm                                 avg_pitch_arm 0.000000e+00
stddev_pitch_arm                           stddev_pitch_arm 0.000000e+00
var_pitch_arm                                 var_pitch_arm 0.000000e+00
avg_yaw_arm                                     avg_yaw_arm 0.000000e+00
stddev_yaw_arm                               stddev_yaw_arm 0.000000e+00
var_yaw_arm                                     var_yaw_arm 0.000000e+00
kurtosis_roll_arm                         kurtosis_roll_arm 0.000000e+00
kurtosis_picth_arm                       kurtosis_picth_arm 0.000000e+00
kurtosis_yaw_arm                           kurtosis_yaw_arm 0.000000e+00
skewness_roll_arm                         skewness_roll_arm 0.000000e+00
skewness_pitch_arm                       skewness_pitch_arm 0.000000e+00
skewness_yaw_arm                           skewness_yaw_arm 0.000000e+00
max_roll_arm                                   max_roll_arm 0.000000e+00
max_picth_arm                                 max_picth_arm 0.000000e+00
max_yaw_arm                                     max_yaw_arm 0.000000e+00
min_roll_arm                                   min_roll_arm 0.000000e+00
min_pitch_arm                                 min_pitch_arm 0.000000e+00
min_yaw_arm                                     min_yaw_arm 0.000000e+00
amplitude_roll_arm                       amplitude_roll_arm 0.000000e+00
amplitude_pitch_arm                     amplitude_pitch_arm 0.000000e+00
amplitude_yaw_arm                         amplitude_yaw_arm 0.000000e+00
kurtosis_roll_dumbbell               kurtosis_roll_dumbbell 0.000000e+00
kurtosis_picth_dumbbell             kurtosis_picth_dumbbell 0.000000e+00
skewness_roll_dumbbell               skewness_roll_dumbbell 0.000000e+00
skewness_pitch_dumbbell             skewness_pitch_dumbbell 0.000000e+00
max_roll_dumbbell                         max_roll_dumbbell 0.000000e+00
max_picth_dumbbell                       max_picth_dumbbell 0.000000e+00
max_yaw_dumbbell                           max_yaw_dumbbell 0.000000e+00
min_roll_dumbbell                         min_roll_dumbbell 0.000000e+00
min_pitch_dumbbell                       min_pitch_dumbbell 0.000000e+00
min_yaw_dumbbell                           min_yaw_dumbbell 0.000000e+00
amplitude_roll_dumbbell             amplitude_roll_dumbbell 0.000000e+00
amplitude_pitch_dumbbell           amplitude_pitch_dumbbell 0.000000e+00
amplitude_yaw_dumbbell               amplitude_yaw_dumbbell 0.000000e+00
var_accel_dumbbell                       var_accel_dumbbell 0.000000e+00
avg_roll_dumbbell                         avg_roll_dumbbell 0.000000e+00
stddev_roll_dumbbell                   stddev_roll_dumbbell 0.000000e+00
var_roll_dumbbell                         var_roll_dumbbell 0.000000e+00
avg_pitch_dumbbell                       avg_pitch_dumbbell 0.000000e+00
```

```
stddev_pitch_dumbbell                          stddev_pitch_dumbbell 0.000000e+00
var_pitch_dumbbell                                var_pitch_dumbbell 0.000000e+00
avg_yaw_dumbbell                                    avg_yaw_dumbbell 0.000000e+00
stddev_yaw_dumbbell                              stddev_yaw_dumbbell 0.000000e+00
var_yaw_dumbbell                                    var_yaw_dumbbell 0.000000e+00
kurtosis_roll_forearm                          kurtosis_roll_forearm 0.000000e+00
kurtosis_picth_forearm                        kurtosis_picth_forearm 0.000000e+00
skewness_roll_forearm                          skewness_roll_forearm 0.000000e+00
skewness_pitch_forearm                        skewness_pitch_forearm 0.000000e+00
max_roll_forearm                                    max_roll_forearm 0.000000e+00
max_picth_forearm                                  max_picth_forearm 0.000000e+00
max_yaw_forearm                                      max_yaw_forearm 0.000000e+00
min_roll_forearm                                    min_roll_forearm 0.000000e+00
min_yaw_forearm                                      min_yaw_forearm 0.000000e+00
amplitude_roll_forearm                        amplitude_roll_forearm 0.000000e+00
amplitude_pitch_forearm                      amplitude_pitch_forearm 0.000000e+00
amplitude_yaw_forearm                          amplitude_yaw_forearm 0.000000e+00
var_accel_forearm                                  var_accel_forearm 0.000000e+00
avg_roll_forearm                                    avg_roll_forearm 0.000000e+00
stddev_roll_forearm                              stddev_roll_forearm 0.000000e+00
var_roll_forearm                                    var_roll_forearm 0.000000e+00
avg_pitch_forearm                                  avg_pitch_forearm 0.000000e+00
stddev_pitch_forearm                            stddev_pitch_forearm 0.000000e+00
var_pitch_forearm                                  var_pitch_forearm 0.000000e+00
avg_yaw_forearm                                      avg_yaw_forearm 0.000000e+00
stddev_yaw_forearm                              stddev_yaw_forearm 0.000000e+00
var_yaw_forearm                                    var_yaw_forearm 0.000000e+00
accel_forearm_y.1                                  accel_forearm_y.1 0.000000e+00
accel_forearm_z.1                                  accel_forearm_z.1 0.000000e+00
magnet_forearm_x.1                                magnet_forearm_x.1 0.000000e+00
magnet_forearm_y.1                                magnet_forearm_y.1 0.000000e+00
magnet_forearm_z.1                                magnet_forearm_z.1 0.000000e+00
classeB                                                      classeB 0.000000e+00
classeC                                                      classeC 0.000000e+00
classeD                                                      classeD 0.000000e+00
> # make predictions
> predictions<- predict(gbm_mod,dataTest)
>
> # append predictions
> pred<- cbind(dataTest,predictions)
>
> # summarize results
> confusionMatrix<- confusionMatrix(pred$predictions,pred$classe)
Error: `data` and `reference` should be factors with the same levels.
> confusionMatrix
Confusion Matrix and Statistics

          Reference
Prediction    A    B    C    D    E
         A 1365    0    0    0    0
         B    0  901    0    0    0
         C    0    0   92    0    0
         D    0    0    0  276    0
         E    0    0    0    0 1370

Overall Statistics
```

```
               Accuracy : 1
                 95% CI : (0.9991, 1)
    No Information Rate : 0.3422
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 1
 Mcnemar's Test P-Value : NA

Statistics by Class:

                     Class: A Class: B Class: C Class: D Class: E
Sensitivity            1.0000    1.000  1.00000  1.00000   1.0000
Specificity            1.0000    1.000  1.00000  1.00000   1.0000
Pos Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Neg Pred Value         1.0000    1.000  1.00000  1.00000   1.0000
Prevalence             0.3409    0.225  0.02298  0.06893   0.3422
Detection Rate         0.3409    0.225  0.02298  0.06893   0.3422
Detection Prevalence   0.3409    0.225  0.02298  0.06893   0.3422
Balanced Accuracy      1.0000    1.000  1.00000  1.00000   1.0000
```