



Session 20 Assignment

Weight Lifting Exercise

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.

1. Use the below given data set
Data Set
2. Perform the below given activities:
 - a. Create classification model using different random forest models
 - b. Verify model goodness of fit
 - c. Apply all the model validation techniques
 - d. Make conclusions
 - e. Plot importance of variables

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

```
library(readr)
```

```
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()
```

```

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)

```

```

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')

```

```

# 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,

```

```

        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)

-----

# 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',

```

```
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 ...
 $ 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_pitch_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_pitch_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 0.35 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 0.35 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 0.17 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_pitch_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_pitch_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 ...
$ 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_pitch_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_pitch_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 -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 -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_pitch_belt"
[13] "skewness_roll_belt"	"skewness_roll_belt.1"	"max_roll_belt"
[16] "max_pitch_belt"	"max_yaw_belt"	"min_roll_belt"
[19] "min_pitch_belt"	"min_yaw_belt"	"amplitude_roll_belt"
[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_arm"
[67] "kurtosis_pitch_arm"	"kurtosis_yaw_arm"	"skewness_roll_arm"
[70] "skewness_pitch_arm"	"skewness_yaw_arm"	"max_roll_arm"
[73] "max_pitch_arm"	"max_yaw_arm"	"min_roll_arm"
[76] "min_pitch_arm"	"min_yaw_arm"	"amplitude_roll_arm"
[79] "amplitude_pitch_arm"	"amplitude_yaw_arm"	"roll_dumbbell"
[82] "pitch_dumbbell"	"yaw_dumbbell"	"kurtosis_roll_dumbbell"
[85] "kurtosis_pitch_dumbbell"	"skewness_roll_dumbbell"	"skewness_pitch_dumbbell"
[88] "max_roll_dumbbell"	"max_pitch_dumbbell"	"max_yaw_dumbbell"
[91] "min_roll_dumbbell"	"min_pitch_dumbbell"	"min_yaw_dumbbell"
[94] "amplitude_roll_dumbbell"	"amplitude_pitch_dumbbell"	"amplitude_yaw_dumbbell"
[97] "total_accel_dumbbell"	"var_accel_dumbbell"	"avg_roll_dumbbell"
[100] "stddev_roll_dumbbell"	"var_roll_dumbbell"	"avg_pitch_dumbbell"
[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_forearm"
[121] "kurtosis_pitch_forearm"	"skewness_roll_forearm"	"skewness_pitch_forearm"

```

[124] "max_roll_forearm"      "max_pitch_forearm"      "max_yaw_forearm"
[127] "min_roll_forearm"      "min_pitch_forearm"      "min_yaw_forearm"
[130] "amplitude_roll_forearm" "amplitude_pitch_forearm" "amplitude_yaw_forearm"
[133] "total_accel_forearm"   "var_accel_forearm"      "avg_roll_forearm"
[136] "stddev_roll_forearm"   "var_roll_forearm"       "avg_pitch_forearm"
[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_window
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_belt
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	-1.0356
6						
	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_belt_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
roll_arm					avg_
1	-267	132	-43.7	-53.6	38
76.22175					65.0977
2	-254	129	-45.3	-49.0	38
76.22175					65.0977
3	-244	125	-46.8	-43.7	35
76.22175					65.0977
4	-221	120	-48.1	-38.1	35
76.22175					65.0977
5	-208	115	-49.1	-31.7	34
76.22175					65.0977
6	-189	110	-49.6	-25.8	33
76.22175					65.0977
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
2	19.0615	35.8809	1287.463	2.79	-0.64
3	19.0615	35.8809	1287.463	2.91	-0.69
4	19.0615	35.8809	1287.463	3.08	-0.72
5	19.0615	35.8809	1287.463	3.20	-0.77
6	19.0615	35.8809	1287.463	3.31	-0.83
accel_arm_x	accel_arm_y	accel_arm_z	magnet_arm_x	magnet_arm_y	magnet_arm_z
1	143	30	-346	556	-205
2	146	35	-339	599	-206
3	156	44	-307	613	-198
4	158	52	-305	646	-186
5	163	55	-288	670	-175
6	160	59	-274	696	-174
kurtosis_roll_arm	kurtosis_pitch_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_pitch_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_arm
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_dumbbell
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_pitch_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_pitch_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_dumbbell			
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_dumbbell			
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_dumbbell_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_pitch_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_pitch_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_fo
rearm_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_fore
arm_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_pitch_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_pitch_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_pitch_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_pitch_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_dumbbell	
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_pitch_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_pitch_dumbbell	max_yaw_dumbbell	
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_dumbbell	
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_dumbbell	
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
_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_pitch_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_pitch_forearm	max_yaw_forearm
m				
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
m				
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
	orearm_x			magnet_f
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	0
B	0	901	0	0	0	0
C	0	0	92	0	0	0
D	0	0	0	276	0	0
E	0	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 function
+
+ # 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_pitch_arm	kurtosis_pitch_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_pitch_arm	max_pitch_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_pitch_dumbbell	kurtosis_pitch_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_pitch_dumbbell	max_pitch_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_pitch_forearm     kurtosis_pitch_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_pitch_forearm          max_pitch_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



