

## Session 17 Assignment

### Weight Lifting Exercise

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)
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.packages('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[1:3020,]

dataTest<-data[3021:4024,]

head(dataTrain)

head(dataTest)

indexNA <- as.vector(sapply(dataTrain[,1:152],function(x) {length(which(is.na(x)))!=0}))

dataTrain <- dataTrain[,!indexNA]

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

model<- train( pitch_belt ~., 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$predictions,pred$pitch_belt)

confusionMatrix

summary(data)

summary(validation)

dim(data)

dim(validation)

#Remove unnecessary columns

# first 7 columns don't contain useful info

data <- data[,-seq(1:7)]

validation <- validation[,-seq(1:7)]

#Remove columns with NAs This reduces de amount of predictors to 53

# select columns that don't have NAs

indexNA <- as.vector(sapply(data[,1:152],function(x) {length(which(is.na(x)))!=0}))

data <- data[,!indexNA]

validation <- validation[,!indexNA]

# set last (classe) and prior (- classe) column index

#last <- as.numeric(ncol(data))

#prior <- last - 1

# set variables to numerics for correlation check, except the "classe"

```

```

for (i in 1:prior) {

  data[,i] <- as.numeric(data[,i])

  validation[,i] <- as.numeric(validation[,i])

}

#check the correlations

cor.check <- cor(data[, -c(last)])

diag(cor.check) <- 0

plot( levelplot(cor.check, main ="Correlation matrix for all WLE features in training set",
               scales=list(x=list(rot=90), cex=1.0)))

# find the highly correlated variables

highly.cor <- findCorrelation(cor(data[, -c(last)]), cutoff=0.9)

# pre process variables

preObj <-preProcess(data[,1:prior],method=c('knnImpute', 'center', 'scale'))

dataPrep <- predict(preObj, data[,1:prior])

dataPrep$classe <- data$classe


valPrep <-predict(preObj,validation[,1:prior])

valPrep$problem_id <- validation$problem_id

# test near zero variance

myDataNZV <- nearZeroVar(dataPrep, saveMetrics=TRUE)

if (any(myDataNZV$nzv)) nzv else message("No variables with near zero variance")

dataPrep <- dataPrep[,myDataNZV$nzv==FALSE]

valPrep <- valPrep[,myDataNZV$nzv==FALSE]

# split dataset into training and test set

```

```

inTrain <- createDataPartition(y=dataPrep$classe, p=0.7, list=FALSE )

training <- dataPrep[inTrain,]

testing <- dataPrep[-inTrain,]

# set seed for reproducibility

set.seed(12345)


# get the best mtry

bestmtry <- tuneRF(training[-last],training$classe, ntreeTry=100,

                  stepFactor=1.5,improve=0.01, trace=TRUE, plot=TRUE, dobest=FALSE)


mtry <- bestmtry[as.numeric(which.min(bestmtry[, "OOBError"])), "mtry"]


# Model 1: RandomForest

wle.rf <- randomForest(classe~.,data=training, mtry=mtry, ntree=501,

                     keep.forest=TRUE, proximity=TRUE,

                     importance=TRUE,test=testing)

# plot the Out of bag error estimates

layout(matrix(c(1,2),nrow=1), width=c(4,1))

par(mar=c(5,4,4,0)) #No margin on the right side

plot(wle.rf, log="y", main ="Out-of-bag (OOB) error estimate per Number of Trees")

par(mar=c(5,0,4,2)) #No margin on the left side

plot(c(0,1),type="n", axes=F, xlab="", ylab="")

legend("top", colnames(wle.rf$err.rate),col=1:6,cex=0.8,fill=1:6)

# plot the accuracy and Gini

varImpPlot(wle.rf, main="Mean Decrease of Accuracy and Gini per variable")

```

```
# MDSplot (we couldn't execute this due to lack of memory)
```

```
MDSplot(wle.rf, training$classe)
```

```
# results with training set
```

```
predict1 <- predict(wle.rf, newdata=training)
```

```
confusionMatrix(predict1,training$classe)
```

```
#Confusion Matrix and Statistics
```

```
# results with test set
```

```
predict2 <- predict(wle.rf, newdata=testing)
```

```
confusionMatrix(predict2,testing$classe)
```

```
# Confusion Matrix and Statistics
```

```
#Train Model 2: Decision Tree
```

```
# Model 2: Decision Tree
```

```
dt <- rpart(classe ~ ., data=training, method="class")
```

```
# fancyRpartPlot works for small trees, but not for ours
```

```
fancyRpartPlot(dt)
```

```
> 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 152 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 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 ...
$ 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)
Loading required package: lattice
Loading required package: ggplot2
> library(randomForest)
randomForest 4.6-14
Type rfNews() to see new features/changes/bug fixes.

```

Attaching package: 'randomForest'

The following object is masked from 'package:ggplot2':

margin

```

> library(rpart)
> library(rpart.plot)
> library(ggplot2)
> library(lattice)
> library(rattle)
Rattle: A free graphical interface for data science with R.
Version 5.1.0 Copyright (c) 2006-2017 Togaware Pty Ltd.
Type 'rattle()' to shake, rattle, and roll your data.

```

Attaching package: 'rattle'

The following object is masked from 'package:randomForest':

importance

```

>
> 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"
 [3] "raw_timestamp_part_2" "cvtd_timestamp"
 [5] "new_window"          "num_window"
 [7] "roll_belt"           "pitch_belt"
 [9] "yaw_belt"            "total_accel_belt"
[11] "kurtosis_roll_belt"  "kurtosis_picth_belt"

```

[13]	"skewness_roll_belt"	"skewness_roll_belt.1"
[15]	"max_roll_belt"	"max_pitch_belt"
[17]	"max_yaw_belt"	"min_roll_belt"
[19]	"min_pitch_belt"	"min_yaw_belt"
[21]	"amplitude_roll_belt"	"amplitude_pitch_belt"
[23]	"amplitude_yaw_belt"	"var_total_accel_belt"
[25]	"avg_roll_belt"	"stddev_roll_belt"
[27]	"var_roll_belt"	"avg_pitch_belt"
[29]	"stddev_pitch_belt"	"var_pitch_belt"
[31]	"avg_yaw_belt"	"stddev_yaw_belt"
[33]	"var_yaw_belt"	"gyros_belt_x"
[35]	"gyros_belt_y"	"gyros_belt_z"
[37]	"accel_belt_x"	"accel_belt_y"
[39]	"accel_belt_z"	"magnet_belt_x"
[41]	"magnet_belt_y"	"magnet_belt_z"
[43]	"roll_arm"	"pitch_arm"
[45]	"yaw_arm"	"total_accel_arm"
[47]	"var_accel_arm"	"avg_roll_arm"
[49]	"stddev_roll_arm"	"var_roll_arm"
[51]	"avg_pitch_arm"	"stddev_pitch_arm"
[53]	"var_pitch_arm"	"avg_yaw_arm"
[55]	"stddev_yaw_arm"	"var_yaw_arm"
[57]	"gyros_arm_x"	"gyros_arm_y"
[59]	"gyros_arm_z"	"accel_arm_x"
[61]	"accel_arm_y"	"accel_arm_z"
[63]	"magnet_arm_x"	"magnet_arm_y"
[65]	"magnet_arm_z"	"kurtosis_roll_arm"
[67]	"kurtosis_pitch_arm"	"kurtosis_yaw_arm"
[69]	"skewness_roll_arm"	"skewness_pitch_arm"
[71]	"skewness_yaw_arm"	"max_roll_arm"
[73]	"max_pitch_arm"	"max_yaw_arm"
[75]	"min_roll_arm"	"min_pitch_arm"
[77]	"min_yaw_arm"	"amplitude_roll_arm"
[79]	"amplitude_pitch_arm"	"amplitude_yaw_arm"
[81]	"roll_dumbbell"	"pitch_dumbbell"
[83]	"yaw_dumbbell"	"kurtosis_roll_dumbbell"
[85]	"kurtosis_pitch_dumbbell"	"skewness_roll_dumbbell"
[87]	"skewness_pitch_dumbbell"	"max_roll_dumbbell"
[89]	"max_pitch_dumbbell"	"max_yaw_dumbbell"
[91]	"min_roll_dumbbell"	"min_pitch_dumbbell"
[93]	"min_yaw_dumbbell"	"amplitude_roll_dumbbell"
[95]	"amplitude_pitch_dumbbell"	"amplitude_yaw_dumbbell"
[97]	"total_accel_dumbbell"	"var_accel_dumbbell"
[99]	"avg_roll_dumbbell"	"stddev_roll_dumbbell"
[101]	"var_roll_dumbbell"	"avg_pitch_dumbbell"
[103]	"stddev_pitch_dumbbell"	"var_pitch_dumbbell"
[105]	"avg_yaw_dumbbell"	"stddev_yaw_dumbbell"
[107]	"var_yaw_dumbbell"	"gyros_dumbbell_x"
[109]	"gyros_dumbbell_y"	"gyros_dumbbell_z"
[111]	"accel_dumbbell_x"	"accel_dumbbell_y"
[113]	"accel_dumbbell_z"	"magnet_dumbbell_x"
[115]	"magnet_dumbbell_y"	"magnet_dumbbell_z"
[117]	"roll_forearm"	"pitch_forearm"
[119]	"yaw_forearm"	"kurtosis_roll_forearm"
[121]	"kurtosis_pitch_forearm"	"skewness_roll_forearm"
[123]	"skewness_pitch_forearm"	"max_roll_forearm"
[125]	"max_pitch_forearm"	"max_yaw_forearm"

```

[127] "min_roll_forearm"      "min_pitch_forearm"
[129] "min_yaw_forearm"      "amplitude_roll_forearm"
[131] "amplitude_pitch_forearm" "amplitude_yaw_forearm"
[133] "total_accel_forearm"  "var_accel_forearm"
[135] "avg_roll_forearm"     "stddev_roll_forearm"
[137] "var_roll_forearm"     "avg_pitch_forearm"
[139] "stddev_pitch_forearm" "var_pitch_forearm"
[141] "avg_yaw_forearm"      "stddev_yaw_forearm"
[143] "var_yaw_forearm"      "gyros_forearm_x"
[145] "gyros_forearm_y"      "gyros_forearm_z"
[147] "accel_forearm_x"      "accel_forearm_y"
[149] "accel_forearm_z"      "magnet_forearm_x"
[151] "magnet_forearm_y"     "magnet_forearm_z"

```

```

> dim(data)
[1] 4024 152
> pairs(data[1:10])
> # enable multi-core processing
> library(doParallel)
Loading required package: foreach
Loading required package: iterators
Loading required package: parallel
> #cl <- makeCluster(detectCores())

```

```
registerDoParallel()
```

```

> set.seed(12345)
> dataTrain<-data[1:3020,]
> dataTest<-data[3021:4024,]
> head(dataTrain)
  user_name raw_timestamp_part_1 raw_timestamp_part_2 cvtd_timestamp
1    eurico      1322489729          34670 28/11/2011 14:15
2    eurico      1322489729          62641 28/11/2011 14:15
3    eurico      1322489729          70653 28/11/2011 14:15
4    eurico      1322489729          82654 28/11/2011 14:15
5    eurico      1322489729          90637 28/11/2011 14:15
6    eurico      1322489729         170626 28/11/2011 14:15
  new_window num_window roll_belt pitch_belt yaw_belt total_accel_belt
1         no          1      3.70      41.6    -82.8              3
2         no          1      3.66      42.8    -82.5              2
3         no          1      3.58      43.7    -82.3              1
4         no          1      3.56      44.4    -82.1              1
5         no          1      3.57      45.1    -81.9              1
6         no          1      3.45      45.6    -81.9              1
  kurtosis_roll_belt kurtosis_pitch_belt skewness_roll_belt
1          -1.03566          -0.39133          0.005406
2          -1.03566          -0.39133          0.005406
3          -1.03566          -0.39133          0.005406
4          -1.03566          -0.39133          0.005406
5          -1.03566          -0.39133          0.005406
6          -1.03566          -0.39133          0.005406
  skewness_roll_belt.1 max_roll_belt max_pitch_belt max_yaw_belt
1          0.045115          -4.1              20             -1
2          0.045115          -4.1              20             -1
3          0.045115          -4.1              20             -1
4          0.045115          -4.1              20             -1
5          0.045115          -4.1              20             -1
6          0.045115          -4.1              20             -1

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	min_roll_belt	min_pitch_belt	min_yaw_belt	amplitude_roll_belt		
1	-7.25	18	-1	1.345		
2	-7.25	18	-1	1.345		
3	-7.25	18	-1	1.345		
4	-7.25	18	-1	1.345		
5	-7.25	18	-1	1.345		
6	-7.25	18	-1	1.345		
	amplitude_pitch_belt	amplitude_yaw_belt	var_total_accel_belt			
1	2	0	0.3			
2	2	0	0.3			
3	2	0	0.3			
4	2	0	0.3			
5	2	0	0.3			
6	2	0	0.3			
	avg_roll_belt	stddev_roll_belt	var_roll_belt	avg_pitch_belt		
1	121.9	0.6	0.35	25.75		
2	121.9	0.6	0.35	25.75		
3	121.9	0.6	0.35	25.75		
4	121.9	0.6	0.35	25.75		
5	121.9	0.6	0.35	25.75		
6	121.9	0.6	0.35	25.75		
	stddev_pitch_belt	var_pitch_belt	avg_yaw_belt	stddev_yaw_belt		
1	0.35	0.1	-4.95	0.4		
2	0.35	0.1	-4.95	0.4		
3	0.35	0.1	-4.95	0.4		
4	0.35	0.1	-4.95	0.4		
5	0.35	0.1	-4.95	0.4		
6	0.35	0.1	-4.95	0.4		
	var_yaw_belt	gyros_belt_x	gyros_belt_y	gyros_belt_z	accel_belt_x	
1	0.17	2.02	0.18	0.02	-3	
2	0.17	1.96	0.14	0.05	-2	
3	0.17	1.88	0.08	0.05	-2	
4	0.17	1.80	0.03	0.08	-6	
5	0.17	1.77	0.00	0.13	-4	
6	0.17	1.75	-0.03	0.16	1	
	accel_belt_y	accel_belt_z	magnet_belt_x	magnet_belt_y	magnet_belt_z	
1	-18	22	387	525	-267	
2	-13	16	405	512	-254	
3	-6	8	409	511	-244	
4	-5	7	422	513	-221	
5	-9	0	418	508	-208	
6	-9	-5	432	510	-189	
	roll_arm	pitch_arm	yaw_arm	total_accel_arm	var_accel_arm	avg_roll_arm
1	132	-43.7	-53.6	38	65.0977	76.22175
2	129	-45.3	-49.0	38	65.0977	76.22175
3	125	-46.8	-43.7	35	65.0977	76.22175
4	120	-48.1	-38.1	35	65.0977	76.22175
5	115	-49.1	-31.7	34	65.0977	76.22175
6	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	

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
gyros_arm_z accel_arm_x accel_arm_y accel_arm_z magnet_arm_x magnet_arm_y					
1	-0.02	143	30	-346	556
2	-0.11	146	35	-339	599
3	-0.15	156	44	-307	613
4	-0.23	158	52	-305	646
5	-0.25	163	55	-288	670
6	-0.30	160	59	-274	696
magnet_arm_z kurtosis_roll_arm kurtosis_pitch_arm kurtosis_yaw_arm					
1	-374	-1.18224	-0.96912	-0.86977	
2	-335	-1.18224	-0.96912	-0.86977	
3	-319	-1.18224	-0.96912	-0.86977	
4	-268	-1.18224	-0.96912	-0.86977	
5	-241	-1.18224	-0.96912	-0.86977	
6	-193	-1.18224	-0.96912	-0.86977	
skewness_roll_arm skewness_pitch_arm skewness_yaw_arm max_roll_arm					
1	0.12353	-0.10319	0.059765	8.45	
2	0.12353	-0.10319	0.059765	8.45	
3	0.12353	-0.10319	0.059765	8.45	
4	0.12353	-0.10319	0.059765	8.45	
5	0.12353	-0.10319	0.059765	8.45	
6	0.12353	-0.10319	0.059765	8.45	
max_pitch_arm max_yaw_arm min_roll_arm min_pitch_arm min_yaw_arm					
1	77.25	38	-33.6	-58.6	10
2	77.25	38	-33.6	-58.6	10
3	77.25	38	-33.6	-58.6	10
4	77.25	38	-33.6	-58.6	10
5	77.25	38	-33.6	-58.6	10
6	77.25	38	-33.6	-58.6	10
amplitude_roll_arm amplitude_pitch_arm amplitude_yaw_arm roll_dumbbell					
1	36.945	121.5	27	51.23554	
2	36.945	121.5	27	55.82442	
3	36.945	121.5	27	55.46983	
4	36.945	121.5	27	55.94486	
5	36.945	121.5	27	55.21174	
6	36.945	121.5	27	54.24731	
pitch_dumbbell yaw_dumbbell kurtosis_roll_dumbbell					
1	11.698847	104.26473	-0.09595		
2	9.645819	100.22805	-0.09595		
3	6.875244	101.08411	-0.09595		
4	11.079297	99.78456	-0.09595		
5	11.426833	100.42258	-0.09595		
6	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	
1	20.2	-0.1	55.71	
2	20.2	-0.1	55.71	
3	20.2	-0.1	55.71	
4	20.2	-0.1	55.71	
5	20.2	-0.1	55.71	
6	20.2	-0.1	55.71	
	amplitude_pitch_dumbbell	amplitude_yaw_dumbbell	total_accel_dumbbell	
1	54.74	0	4	
2	54.74	0	4	
3	54.74	0	4	
4	54.74	0	5	
5	54.74	0	4	
6	54.74	0	4	
	var_accel_dumbbell	avg_roll_dumbbell	stddev_roll_dumbbell	
1	2.41635	-5.11805	17.058	
2	2.41635	-5.11805	17.058	
3	2.41635	-5.11805	17.058	
4	2.41635	-5.11805	17.058	
5	2.41635	-5.11805	17.058	
6	2.41635	-5.11805	17.058	
	var_roll_dumbbell	avg_pitch_dumbbell	stddev_pitch_dumbbell	
1	291.001	13.9312	14.1062	
2	291.001	13.9312	14.1062	
3	291.001	13.9312	14.1062	
4	291.001	13.9312	14.1062	
5	291.001	13.9312	14.1062	
6	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
1	-0.31	0.16	0.08	5
2	-0.31	0.14	0.07	4
3	-0.31	0.16	0.05	3
4	-0.31	0.16	0.07	5
5	-0.31	0.14	0.07	5
6	-0.31	0.14	0.07	6
	accel_dumbbell_y	accel_dumbbell_z	magnet_dumbbell_x	magnet_dumbbell_y
1	21	37	-471	191
2	22	35	-472	184
3	23	37	-468	190
4	24	38	-469	184
5	23	37	-468	189
6	22	36	-473	188
	magnet_dumbbell_z	roll_forearm	pitch_forearm	yaw_forearm
1	277	-111	26.5	138
2	281	-112	26.2	138

3	275	-114	26.0	137
4	285	-115	25.8	137
5	292	-117	25.5	137
6	278	-118	25.1	137
kurtosis_roll_forearm kurtosis_pitch_forearm skewness_roll_forearm				
1	-1.09475		-0.97525	-0.05065
2	-1.09475		-0.97525	-0.05065
3	-1.09475		-0.97525	-0.05065
4	-1.09475		-0.97525	-0.05065
5	-1.09475		-0.97525	-0.05065
6	-1.09475		-0.97525	-0.05065
skewness_pitch_forearm max_roll_forearm max_pitch_forearm max_yaw_forearm				
1	0.17285	49.6	168	-1.1
2	0.17285	49.6	168	-1.1
3	0.17285	49.6	168	-1.1
4	0.17285	49.6	168	-1.1
5	0.17285	49.6	168	-1.1
6	0.17285	49.6	168	-1.1
min_roll_forearm min_pitch_forearm min_yaw_forearm amplitude_roll_forearm				
1	4.65	-168.5	-1.1	32.2
2	4.65	-168.5	-1.1	32.2
3	4.65	-168.5	-1.1	32.2
4	4.65	-168.5	-1.1	32.2
5	4.65	-168.5	-1.1	32.2
6	4.65	-168.5	-1.1	32.2
amplitude_pitch_forearm amplitude_yaw_forearm total_accel_forearm				
1	341.5	0	30	
2	341.5	0	31	
3	341.5	0	32	
4	341.5	0	33	
5	341.5	0	34	
6	341.5	0	36	
var_accel_forearm avg_roll_forearm stddev_roll_forearm var_roll_forearm				
1	14.0772	27.85936	45.16342	2749.163
2	14.0772	27.85936	45.16342	2749.163
3	14.0772	27.85936	45.16342	2749.163
4	14.0772	27.85936	45.16342	2749.163
5	14.0772	27.85936	45.16342	2749.163
6	14.0772	27.85936	45.16342	2749.163
avg_pitch_forearm stddev_pitch_forearm var_pitch_forearm avg_yaw_forearm				
1	25.35597	8.906695	79.33451	17.09505
2	25.35597	8.906695	79.33451	17.09505
3	25.35597	8.906695	79.33451	17.09505
4	25.35597	8.906695	79.33451	17.09505
5	25.35597	8.906695	79.33451	17.09505
6	25.35597	8.906695	79.33451	17.09505
stddev_yaw_forearm var_yaw_forearm gyros_forearm_x gyros_forearm_y				
1	74.27584	5541.956	-0.05	-0.37
2	74.27584	5541.956	-0.06	-0.37
3	74.27584	5541.956	-0.05	-0.27
4	74.27584	5541.956	0.02	-0.24
5	74.27584	5541.956	0.08	-0.27
6	74.27584	5541.956	0.14	-0.29
gyros_forearm_z accel_forearm_x accel_forearm_y accel_forearm_z				
1	-0.43	-170	155	184
2	-0.59	-178	164	182
3	-0.72	-182	172	185

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4          -0.79          -185          182          188
5          -0.82          -188          195          188
6          -0.82          -208          207          190
  magnet_forearm_x magnet_forearm_y magnet_forearm_z
1          -1160          1400          -876
2          -1150          1410          -871
3          -1130          1400          -863
4          -1120          1400          -855
5          -1100          1400          -843
6          -1090          1400          -838
> head(dataTest)
  user_name raw_timestamp_part_1 raw_timestamp_part_2 cvtd_timestamp
3021   pedro          1323094996          656284 5/12/2011 14:23
3022   pedro          1323094996          664357 5/12/2011 14:23
3023   pedro          1323094996          672361 5/12/2011 14:23
3024   pedro          1323094996          692335 5/12/2011 14:23
3025   pedro          1323094996          700442 5/12/2011 14:23
3026   pedro          1323094996          712340 5/12/2011 14:23
  new_window num_window roll_belt pitch_belt yaw_belt total_accel_belt
3021       no         69      125      25.9      -3.24             20
3022       no         69      125      25.8      -3.13             20
3023       no         69      125      25.8      -3.07             20
3024       no         69      125      25.7      -3.01             20
3025       no         69      125      25.7      -2.96             20
3026       no         69      125      25.6      -2.80             20
  kurtosis_roll_belt kurtosis_pitch_belt skewness_roll_belt
3021          -1.03566          -0.39133          0.005406
3022          -1.03566          -0.39133          0.005406
3023          -1.03566          -0.39133          0.005406
3024          -1.03566          -0.39133          0.005406
3025          -1.03566          -0.39133          0.005406
3026          -1.03566          -0.39133          0.005406
  skewness_roll_belt.1 max_roll_belt max_pitch_belt max_yaw_belt
3021          0.045115          -4.1             20          -1
3022          0.045115          -4.1             20          -1
3023          0.045115          -4.1             20          -1
3024          0.045115          -4.1             20          -1
3025          0.045115          -4.1             20          -1
3026          0.045115          -4.1             20          -1
  min_roll_belt min_pitch_belt min_yaw_belt amplitude_roll_belt
3021          -7.25             18             -1          1.345
3022          -7.25             18             -1          1.345
3023          -7.25             18             -1          1.345
3024          -7.25             18             -1          1.345
3025          -7.25             18             -1          1.345
3026          -7.25             18             -1          1.345
  amplitude_pitch_belt amplitude_yaw_belt var_total_accel_belt
3021                 2                 0                 0.3
3022                 2                 0                 0.3
3023                 2                 0                 0.3
3024                 2                 0                 0.3
3025                 2                 0                 0.3
3026                 2                 0                 0.3
  avg_roll_belt stddev_roll_belt var_roll_belt avg_pitch_belt
3021          121.9             0.6             0.35          25.75
3022          121.9             0.6             0.35          25.75
3023          121.9             0.6             0.35          25.75

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3024	121.9	0.6	0.35	25.75		
3025	121.9	0.6	0.35	25.75		
3026	121.9	0.6	0.35	25.75		
	stddev_pitch_belt	var_pitch_belt	avg_yaw_belt	stddev_yaw_belt		
3021	0.35	0.1	-4.95	0.4		
3022	0.35	0.1	-4.95	0.4		
3023	0.35	0.1	-4.95	0.4		
3024	0.35	0.1	-4.95	0.4		
3025	0.35	0.1	-4.95	0.4		
3026	0.35	0.1	-4.95	0.4		
	var_yaw_belt	gyros_belt_x	gyros_belt_y	gyros_belt_z	accel_belt_x	
3021	0.17	-0.37	-0.02	-0.43	-40	
3022	0.17	-0.37	-0.02	-0.43	-42	
3023	0.17	-0.39	-0.02	-0.44	-43	
3024	0.17	-0.39	-0.02	-0.44	-42	
3025	0.17	-0.39	-0.02	-0.44	-40	
3026	0.17	-0.39	-0.02	-0.43	-42	
	accel_belt_y	accel_belt_z	magnet_belt_x	magnet_belt_y	magnet_belt_z	
3021	71	-175	2	579	-375	
3022	72	-178	-2	581	-390	
3023	71	-179	5	579	-387	
3024	69	-178	4	575	-389	
3025	68	-177	5	584	-368	
3026	70	-177	7	575	-389	
	roll_arm	pitch_arm	yaw_arm	total_accel_arm	var_accel_arm	avg_roll_arm
3021	-24.7	6.42	-115	6	65.0977	76.22175
3022	-25.0	6.61	-115	5	65.0977	76.22175
3023	-25.2	6.71	-116	5	65.0977	76.22175
3024	-25.5	6.70	-116	4	65.0977	76.22175
3025	-25.6	6.61	-116	4	65.0977	76.22175
3026	-25.5	6.43	-117	3	65.0977	76.22175
	stddev_roll_arm	var_roll_arm	avg_pitch_arm	stddev_pitch_arm		
3021	16.1039	259.3599	-10.1695	10.66725		
3022	16.1039	259.3599	-10.1695	10.66725		
3023	16.1039	259.3599	-10.1695	10.66725		
3024	16.1039	259.3599	-10.1695	10.66725		
3025	16.1039	259.3599	-10.1695	10.66725		
3026	16.1039	259.3599	-10.1695	10.66725		
	var_pitch_arm	avg_yaw_arm	stddev_yaw_arm	var_yaw_arm	gyros_arm_x	
3021	113.7978	19.0615	35.8809	1287.463	0.47	
3022	113.7978	19.0615	35.8809	1287.463	0.34	
3023	113.7978	19.0615	35.8809	1287.463	0.22	
3024	113.7978	19.0615	35.8809	1287.463	0.14	
3025	113.7978	19.0615	35.8809	1287.463	0.10	
3026	113.7978	19.0615	35.8809	1287.463	0.03	
	gyros_arm_y	gyros_arm_z	accel_arm_x	accel_arm_y	accel_arm_z	
3021	-0.37	-0.13	-4	14	56	
3022	-0.27	-0.31	-2	15	49	
3023	-0.19	-0.44	6	6	49	
3024	-0.13	-0.49	7	3	42	
3025	-0.10	-0.44	7	4	37	
3026	-0.10	-0.39	5	3	33	
	magnet_arm_x	magnet_arm_y	magnet_arm_z	kurtosis_roll_arm		
3021	-378	385	448	-1.18224		
3022	-389	377	454	-1.18224		
3023	-392	372	461	-1.18224		
3024	-391	369	463	-1.18224		

3025	-395	369	453	-1.18224	
3026	-399	360	461	-1.18224	
	kurtosis_pitch_arm	kurtosis_yaw_arm	skewness_roll_arm		
3021	-0.96912	-0.86977	0.12353		
3022	-0.96912	-0.86977	0.12353		
3023	-0.96912	-0.86977	0.12353		
3024	-0.96912	-0.86977	0.12353		
3025	-0.96912	-0.86977	0.12353		
3026	-0.96912	-0.86977	0.12353		
	skewness_pitch_arm	skewness_yaw_arm	max_roll_arm	max_pitch_arm	
3021	-0.10319	0.059765	8.45	77.25	
3022	-0.10319	0.059765	8.45	77.25	
3023	-0.10319	0.059765	8.45	77.25	
3024	-0.10319	0.059765	8.45	77.25	
3025	-0.10319	0.059765	8.45	77.25	
3026	-0.10319	0.059765	8.45	77.25	
	max_yaw_arm	min_roll_arm	min_pitch_arm	min_yaw_arm	amplitude_roll_arm
3021	38	-33.6	-58.6	10	36.945
3022	38	-33.6	-58.6	10	36.945
3023	38	-33.6	-58.6	10	36.945
3024	38	-33.6	-58.6	10	36.945
3025	38	-33.6	-58.6	10	36.945
3026	38	-33.6	-58.6	10	36.945
	amplitude_pitch_arm	amplitude_yaw_arm	roll_dumbbell	pitch_dumbbell	
3021	121.5	27	2.239617	27.20759	
3022	121.5	27	-2.321713	27.02507	
3023	121.5	27	1.132156	27.51712	
3024	121.5	27	-6.717451	30.68508	
3025	121.5	27	-11.203061	29.49277	
3026	121.5	27	-4.579686	31.41632	
	yaw_dumbbell	kurtosis_roll_dumbbell	kurtosis_pitch_dumbbell		
3021	129.7753	-0.09595	-0.4422		
3022	129.9500	-0.09595	-0.4422		
3023	129.5380	-0.09595	-0.4422		
3024	125.6207	-0.09595	-0.4422		
3025	125.4100	-0.09595	-0.4422		
3026	125.3085	-0.09595	-0.4422		
	skewness_roll_dumbbell	skewness_pitch_dumbbell	max_roll_dumbbell		
3021	0.0819	-0.216	41.85		
3022	0.0819	-0.216	41.85		
3023	0.0819	-0.216	41.85		
3024	0.0819	-0.216	41.85		
3025	0.0819	-0.216	41.85		
3026	0.0819	-0.216	41.85		
	max_pitch_dumbbell	max_yaw_dumbbell	min_roll_dumbbell		
3021	133	-0.1	-26.75		
3022	133	-0.1	-26.75		
3023	133	-0.1	-26.75		
3024	133	-0.1	-26.75		
3025	133	-0.1	-26.75		
3026	133	-0.1	-26.75		
	min_pitch_dumbbell	min_yaw_dumbbell	amplitude_roll_dumbbell		
3021	20.2	-0.1	55.71		
3022	20.2	-0.1	55.71		
3023	20.2	-0.1	55.71		
3024	20.2	-0.1	55.71		
3025	20.2	-0.1	55.71		

3026	20.2	-0.1	55.71	
	amplitude_pitch_dumbbell	amplitude_yaw_dumbbell	total_accel_dumbbell	
3021	54.74	0		9
3022	54.74	0		9
3023	54.74	0		9
3024	54.74	0		9
3025	54.74	0		9
3026	54.74	0		9
	var_accel_dumbbell	avg_roll_dumbbell	stddev_roll_dumbbell	
3021	2.41635	-5.11805	17.058	
3022	2.41635	-5.11805	17.058	
3023	2.41635	-5.11805	17.058	
3024	2.41635	-5.11805	17.058	
3025	2.41635	-5.11805	17.058	
3026	2.41635	-5.11805	17.058	
	var_roll_dumbbell	avg_pitch_dumbbell	stddev_pitch_dumbbell	
3021	291.001	13.9312	14.1062	
3022	291.001	13.9312	14.1062	
3023	291.001	13.9312	14.1062	
3024	291.001	13.9312	14.1062	
3025	291.001	13.9312	14.1062	
3026	291.001	13.9312	14.1062	
	var_pitch_dumbbell	avg_yaw_dumbbell	stddev_yaw_dumbbell	
3021	199.0775	64.7063	13.5747	
3022	199.0775	64.7063	13.5747	
3023	199.0775	64.7063	13.5747	
3024	199.0775	64.7063	13.5747	
3025	199.0775	64.7063	13.5747	
3026	199.0775	64.7063	13.5747	
	var_yaw_dumbbell	gyros_dumbbell_x	gyros_dumbbell_y	gyros_dumbbell_z
3021	184.5578	0.47	-0.19	-0.13
3022	184.5578	0.47	-0.19	-0.15
3023	184.5578	0.47	-0.22	-0.16
3024	184.5578	0.50	-0.21	-0.18
3025	184.5578	0.50	-0.18	-0.18
3026	184.5578	0.48	-0.14	-0.16
	accel_dumbbell_x	accel_dumbbell_y	accel_dumbbell_z	magnet_dumbbell_x
3021	24	2	86	529
3022	23	-2	83	540
3023	24	1	85	533
3024	27	-6	85	534
3025	26	-10	85	537
3026	27	-4	83	542
	magnet_dumbbell_y	magnet_dumbbell_z	roll_forearm	pitch_forearm
3021	-521	-91	115	16.3
3022	-516	-99	115	17.2
3023	-518	-92	116	18.1
3024	-506	-90	116	19.2
3025	-512	-88	117	20.5
3026	-517	-94	117	21.9
	yaw_forearm	kurtosis_roll_forearm	kurtosis_pitch_forearm	
3021	87.7	-1.09475	-0.97525	
3022	89.0	-1.09475	-0.97525	
3023	90.4	-1.09475	-0.97525	
3024	91.9	-1.09475	-0.97525	
3025	93.4	-1.09475	-0.97525	
3026	94.8	-1.09475	-0.97525	

	skewness_roll_forearm	skewness_pitch_forearm	max_roll_forearm	
3021	-0.05065	0.17285	49.6	
3022	-0.05065	0.17285	49.6	
3023	-0.05065	0.17285	49.6	
3024	-0.05065	0.17285	49.6	
3025	-0.05065	0.17285	49.6	
3026	-0.05065	0.17285	49.6	
	max_pitch_forearm	max_yaw_forearm	min_roll_forearm	min_pitch_forearm
3021	168	-1.1	4.65	-168.5
3022	168	-1.1	4.65	-168.5
3023	168	-1.1	4.65	-168.5
3024	168	-1.1	4.65	-168.5
3025	168	-1.1	4.65	-168.5
3026	168	-1.1	4.65	-168.5
	min_yaw_forearm	amplitude_roll_forearm	amplitude_pitch_forearm	
3021	-1.1	32.2	341.5	
3022	-1.1	32.2	341.5	
3023	-1.1	32.2	341.5	
3024	-1.1	32.2	341.5	
3025	-1.1	32.2	341.5	
3026	-1.1	32.2	341.5	
	amplitude_yaw_forearm	total_accel_forearm	var_accel_forearm	
3021	0	36	14.0772	
3022	0	36	14.0772	
3023	0	37	14.0772	
3024	0	37	14.0772	
3025	0	37	14.0772	
3026	0	38	14.0772	
	avg_roll_forearm	stddev_roll_forearm	var_roll_forearm	
3021	27.85936	45.16342	2749.163	
3022	27.85936	45.16342	2749.163	
3023	27.85936	45.16342	2749.163	
3024	27.85936	45.16342	2749.163	
3025	27.85936	45.16342	2749.163	
3026	27.85936	45.16342	2749.163	
	avg_pitch_forearm	stddev_pitch_forearm	var_pitch_forearm	
3021	25.35597	8.906695	79.33451	
3022	25.35597	8.906695	79.33451	
3023	25.35597	8.906695	79.33451	
3024	25.35597	8.906695	79.33451	
3025	25.35597	8.906695	79.33451	
3026	25.35597	8.906695	79.33451	
	avg_yaw_forearm	stddev_yaw_forearm	var_yaw_forearm	gyros_forearm_x
3021	17.09505	74.27584	5541.956	0.42
3022	17.09505	74.27584	5541.956	0.50
3023	17.09505	74.27584	5541.956	0.55
3024	17.09505	74.27584	5541.956	0.58
3025	17.09505	74.27584	5541.956	0.51
3026	17.09505	74.27584	5541.956	0.40
	gyros_forearm_y	gyros_forearm_z	accel_forearm_x	accel_forearm_y
3021	-0.87	-0.02	105	293
3022	-0.90	0.07	80	300
3023	-1.01	0.08	79	316
3024	-1.24	0.03	60	317
3025	-1.32	-0.10	42	317
3026	-1.30	-0.23	40	325
	accel_forearm_z	magnet_forearm_x	magnet_forearm_y	magnet_forearm_z

```

3021          -164          -275          791          694
3022          -161          -290          792          678
3023          -164          -300          794          682
3024          -169          -322          794          672
3025          -171          -341          787          676
3026          -170          -343          785          681
> train_control<- trainControl(method="cv", number=10)
>
> model<- train( pitch_belt ~., data=dataTrain,trControl=train_control, metho
d="rf")

```

## Random Forest

3020 samples  
151 predictor

No pre-processing

Resampling: Cross-Validated (10 fold)

Summary of sample sizes: 2718, 2718, 2716, 2719, 2718, 2720, ...

Resampling results across tuning parameters:

mtry	RMSE	Rsquared	MAE
2	3.7719395	0.9858292	2.0072729
80	0.4378226	0.9994475	0.1698078
159	0.5446360	0.9991612	0.1890224

RMSE was used to select the optimal model using the smallest value.

The final value used for the model was mtry = 80.

```

> summary(data)
      X      user_name      raw_timestamp_part_1 raw_timestamp_part_2
Min.   :      1      adelmo :3892      Min.   :1.322e+09      Min.   :      294
1st Qu.: 4906      carlitos:3112      1st Qu.:1.323e+09      1st Qu.:252912
Median : 9812      charles :3536      Median :1.323e+09      Median :496380
Mean   : 9812      eurico  :3070      Mean   :1.323e+09      Mean   :500656
3rd Qu.:14717      jeremy  :3402      3rd Qu.:1.323e+09      3rd Qu.:751891
Max.   :19622      pedro   :2610      Max.   :1.323e+09      Max.   :998801
      cvtd_timestamp new_window      num_window      roll_belt
28/11/2011 14:14: 1498      no :19216      Min.   :      1.0      Min.   : -28.90
05/12/2011 11:24: 1497      yes:  406      1st Qu.:222.0      1st Qu.:      1.10
30/11/2011 17:11: 1440                                Median :424.0      Median :113.00
05/12/2011 11:25: 1425                                Mean   :430.6      Mean   :  64.41
02/12/2011 14:57: 1380                                3rd Qu.:644.0      3rd Qu.:123.00
02/12/2011 13:34: 1375                                Max.   :864.0      Max.   :162.00
      pitch_belt      yaw_belt      total_accel_belt kurtosis_roll_belt
Min.   : -55.8000      Min.   : -180.00      Min.   :  0.00      Min.   : -2.121
1st Qu.:  1.7600      1st Qu.:  -88.30      1st Qu.:  3.00      1st Qu.: -1.329
Median :  5.2800      Median :  -13.00      Median :17.00      Median : -0.899
Mean   :  0.3053      Mean   :  -11.21      Mean   :11.31      Mean   : -0.220
3rd Qu.: 14.9000      3rd Qu.:   12.90      3rd Qu.:18.00      3rd Qu.: -0.219
Max.   : 60.3000      Max.   : 179.00      Max.   :29.00      Max.   :33.000
      kurtosis_pitch_belt kurtosis_yaw_belt skewness_roll_belt
Min.   : -2.190      Mode:logical      Min.   : -5.745
1st Qu.: -1.107      NA's:19622      1st Qu.: -0.444
Median : -0.151                                Median :  0.000

```

Mean : 4.334		Mean : -0.026	
3rd Qu.: 3.178		3rd Qu.: 0.417	
Max. : 58.000		Max. : 3.595	
skewness_roll_belt.1	skewness_yaw_belt	max_roll_belt	max_pitch_belt
Min. : -7.616	Mode:logical	Min. : -94.300	Min. : 3.00
1st Qu.: -1.114	NA's:19622	1st Qu.: -88.000	1st Qu.: 5.00
Median : -0.068		Median : -5.100	Median : 18.00
Mean : -0.296		Mean : -6.667	Mean : 12.92
3rd Qu.: 0.661		3rd Qu.: 18.500	3rd Qu.: 19.00
Max. : 7.348		Max. : 180.000	Max. : 30.00
max_yaw_belt	min_roll_belt	min_pitch_belt	min_yaw_belt
Min. : -2.10	Min. : -180.00	Min. : 0.00	Min. : -2.10
1st Qu.: -1.30	1st Qu.: -88.40	1st Qu.: 3.00	1st Qu.: -1.30
Median : -0.90	Median : -7.85	Median : 16.00	Median : -0.90
Mean : -0.22	Mean : -10.44	Mean : 10.76	Mean : -0.22
3rd Qu.: -0.20	3rd Qu.: 9.05	3rd Qu.: 17.00	3rd Qu.: -0.20
Max. : 33.00	Max. : 173.00	Max. : 23.00	Max. : 33.00
amplitude_roll_belt	amplitude_pitch_belt	amplitude_yaw_belt	
Min. : 0.000	Min. : 0.000	Min. : 0	
1st Qu.: 0.300	1st Qu.: 1.000	1st Qu.: 0	
Median : 1.000	Median : 1.000	Median : 0	
Mean : 3.769	Mean : 2.167	Mean : 0	
3rd Qu.: 2.083	3rd Qu.: 2.000	3rd Qu.: 0	
Max. : 360.000	Max. : 12.000	Max. : 0	
var_total_accel_belt	avg_roll_belt	stddev_roll_belt	var_roll_belt
Min. : 0.000	Min. : -27.40	Min. : 0.000	Min. : 0.000
1st Qu.: 0.100	1st Qu.: 1.10	1st Qu.: 0.200	1st Qu.: 0.000
Median : 0.200	Median : 116.35	Median : 0.400	Median : 0.100
Mean : 0.926	Mean : 68.06	Mean : 1.337	Mean : 7.699
3rd Qu.: 0.300	3rd Qu.: 123.38	3rd Qu.: 0.700	3rd Qu.: 0.500
Max. : 16.500	Max. : 157.40	Max. : 14.200	Max. : 200.700
avg_pitch_belt	stddev_pitch_belt	var_pitch_belt	avg_yaw_belt
Min. : -51.400	Min. : 0.000	Min. : 0.000	Min. : -138.300
1st Qu.: 2.025	1st Qu.: 0.200	1st Qu.: 0.000	1st Qu.: -88.175
Median : 5.200	Median : 0.400	Median : 0.100	Median : -6.550
Mean : 0.520	Mean : 0.603	Mean : 0.766	Mean : -8.831
3rd Qu.: 15.775	3rd Qu.: 0.700	3rd Qu.: 0.500	3rd Qu.: 14.125
Max. : 59.700	Max. : 4.000	Max. : 16.200	Max. : 173.500
stddev_yaw_belt	var_yaw_belt	gyros_belt_x	
Min. : 0.000	Min. : 0.000	Min. : -1.040000	
1st Qu.: 0.100	1st Qu.: 0.010	1st Qu.: -0.030000	
Median : 0.300	Median : 0.090	Median : 0.030000	
Mean : 1.341	Mean : 107.487	Mean : -0.005592	
3rd Qu.: 0.700	3rd Qu.: 0.475	3rd Qu.: 0.110000	
Max. : 176.600	Max. : 31183.240	Max. : 2.220000	
gyros_belt_y	gyros_belt_z	accel_belt_x	accel_belt_y
Min. : -0.64000	Min. : -1.4600	Min. : -120.000	Min. : -69.00
1st Qu.: 0.00000	1st Qu.: -0.2000	1st Qu.: -21.000	1st Qu.: 3.00
Median : 0.02000	Median : -0.1000	Median : -15.000	Median : 35.00
Mean : 0.03959	Mean : -0.1305	Mean : -5.595	Mean : 30.15
3rd Qu.: 0.11000	3rd Qu.: -0.0200	3rd Qu.: -5.000	3rd Qu.: 61.00
Max. : 0.64000	Max. : 1.6200	Max. : 85.000	Max. : 164.00
accel_belt_z	magnet_belt_x	magnet_belt_y	magnet_belt_z
Min. : -275.00	Min. : -52.0	Min. : 354.0	Min. : -623.0
1st Qu.: -162.00	1st Qu.: 9.0	1st Qu.: 581.0	1st Qu.: -375.0
Median : -152.00	Median : 35.0	Median : 601.0	Median : -320.0
Mean : -72.59	Mean : 55.6	Mean : 593.7	Mean : -345.5

3rd Qu.: 27.00	3rd Qu.: 59.0	3rd Qu.:610.0	3rd Qu.: -306.0
Max. : 105.00	Max. :485.0	Max. :673.0	Max. : 293.0
roll_arm	pitch_arm	yaw_arm	total_accel_arm
Min. : -180.00	Min. : -88.800	Min. : -180.0000	Min. : 1.00
1st Qu.: -31.77	1st Qu.: -25.900	1st Qu.: -43.1000	1st Qu.:17.00
Median : 0.00	Median : 0.000	Median : 0.0000	Median :27.00
Mean : 17.83	Mean : -4.612	Mean : -0.6188	Mean :25.51
3rd Qu.: 77.30	3rd Qu.: 11.200	3rd Qu.: 45.8750	3rd Qu.:33.00
Max. : 180.00	Max. : 88.500	Max. : 180.0000	Max. :66.00
var_accel_arm	avg_roll_arm	stddev_roll_arm	var_roll_arm
Min. : 0.00	Min. : -166.67	Min. : 0.000	Min. : 0.000
1st Qu.: 9.03	1st Qu.: -38.37	1st Qu.: 1.376	1st Qu.: 1.898
Median : 40.61	Median : 0.00	Median : 5.702	Median : 32.517
Mean : 53.23	Mean : 12.68	Mean : 11.201	Mean : 417.264
3rd Qu.: 75.62	3rd Qu.: 76.33	3rd Qu.: 14.921	3rd Qu.: 222.647
Max. :331.70	Max. : 163.33	Max. :161.964	Max. :26232.208
avg_pitch_arm	stddev_pitch_arm	var_pitch_arm	avg_yaw_arm
Min. : -81.773	Min. : 0.000	Min. : 0.000	Min. : -173.440
1st Qu.: -22.770	1st Qu.: 1.642	1st Qu.: 2.697	1st Qu.: -29.198
Median : 0.000	Median : 8.133	Median : 66.146	Median : 0.000
Mean : -4.901	Mean :10.383	Mean : 195.864	Mean : 2.359
3rd Qu.: 8.277	3rd Qu.:16.327	3rd Qu.: 266.576	3rd Qu.: 38.185
Max. : 75.659	Max. :43.412	Max. :1884.565	Max. : 152.000
stddev_yaw_arm	var_yaw_arm	gyros_arm_x	gyros_arm_y
Min. : 0.000	Min. : 0.000	Min. : -6.37000	Min. : -3.4400
1st Qu.: 2.577	1st Qu.: 6.642	1st Qu.: -1.33000	1st Qu.: -0.8000
Median : 16.682	Median : 278.309	Median : 0.08000	Median : -0.2400
Mean : 22.270	Mean : 1055.933	Mean : 0.04277	Mean : -0.2571
3rd Qu.: 35.984	3rd Qu.: 1294.850	3rd Qu.: 1.57000	3rd Qu.: 0.1400
Max. :177.044	Max. :31344.568	Max. : 4.87000	Max. : 2.8400
gyros_arm_z	accel_arm_x	accel_arm_y	accel_arm_z
Min. : -2.3300	Min. : -404.00	Min. : -318.0	Min. : -636.00
1st Qu.: -0.0700	1st Qu.: -242.00	1st Qu.: -54.0	1st Qu.: -143.00
Median : 0.2300	Median : -44.00	Median : 14.0	Median : -47.00
Mean : 0.2695	Mean : -60.24	Mean : 32.6	Mean : -71.25
3rd Qu.: 0.7200	3rd Qu.: 84.00	3rd Qu.: 139.0	3rd Qu.: 23.00
Max. : 3.0200	Max. : 437.00	Max. : 308.0	Max. : 292.00
magnet_arm_x	magnet_arm_y	magnet_arm_z	kurtosis_roll_arm
Min. : -584.0	Min. : -392.0	Min. : -597.0	Min. : -1.809
1st Qu.: -300.0	1st Qu.: -9.0	1st Qu.: 131.2	1st Qu.: -1.345
Median : 289.0	Median : 202.0	Median : 444.0	Median : -0.894
Mean : 191.7	Mean : 156.6	Mean : 306.5	Mean : -0.366
3rd Qu.: 637.0	3rd Qu.: 323.0	3rd Qu.: 545.0	3rd Qu.: -0.038
Max. : 782.0	Max. : 583.0	Max. : 694.0	Max. :21.456
kurtosis_pitch_arm	kurtosis_yaw_arm	skewness_roll_arm	skewness_pitch_arm
Min. : -2.084	Min. : -2.103	Min. : -2.541	Min. : -4.565
1st Qu.: -1.280	1st Qu.: -1.220	1st Qu.: -0.561	1st Qu.: -0.618
Median : -1.010	Median : -0.733	Median : 0.040	Median : -0.035
Mean : -0.542	Mean : 0.406	Mean : 0.068	Mean : -0.065
3rd Qu.: -0.379	3rd Qu.: 0.115	3rd Qu.: 0.671	3rd Qu.: 0.454
Max. :19.751	Max. :56.000	Max. : 4.394	Max. : 3.043
skewness_yaw_arm	max_roll_arm	max_pitch_arm	max_yaw_arm
Min. : -6.708	Min. : -73.100	Min. : -173.000	Min. : 4.00
1st Qu.: -0.743	1st Qu.: -0.175	1st Qu.: -1.975	1st Qu.:29.00
Median : -0.133	Median : 4.950	Median : 23.250	Median :34.00
Mean : -0.229	Mean : 11.236	Mean : 35.751	Mean :35.46
3rd Qu.: 0.344	3rd Qu.: 26.775	3rd Qu.: 95.975	3rd Qu.:41.00

Max. : 7.483	Max. : 85.500	Max. : 180.000	Max. : 65.00
min_roll_arm	min_pitch_arm	min_yaw_arm	amplitude_roll_arm
Min. : -89.10	Min. : -180.00	Min. : 1.00	Min. : 0.000
1st Qu.: -41.98	1st Qu.: -72.62	1st Qu.: 8.00	1st Qu.: 5.425
Median : -22.45	Median : -33.85	Median : 13.00	Median : 28.450
Mean : -21.22	Mean : -33.92	Mean : 14.66	Mean : 32.452
3rd Qu.: 0.00	3rd Qu.: 0.00	3rd Qu.: 19.00	3rd Qu.: 50.960
Max. : 66.40	Max. : 152.00	Max. : 38.00	Max. : 119.500
amplitude_pitch_arm	amplitude_yaw_arm	roll_dumbbell	pitch_dumbbell
Min. : 0.000	Min. : 0.00	Min. : -153.71	Min. : -149.59
1st Qu.: 9.925	1st Qu.: 13.00	1st Qu.: -18.49	1st Qu.: -40.89
Median : 54.900	Median : 22.00	Median : 48.17	Median : -20.96
Mean : 69.677	Mean : 20.79	Mean : 23.84	Mean : -10.78
3rd Qu.: 115.175	3rd Qu.: 28.75	3rd Qu.: 67.61	3rd Qu.: 17.50
Max. : 360.000	Max. : 52.00	Max. : 153.55	Max. : 149.40
yaw_dumbbell	kurtosis_roll_dumbbell	kurtosis_pitch_dumbbell	
Min. : -150.871	Min. : -2.174	Min. : -2.200	
1st Qu.: -77.644	1st Qu.: -0.682	1st Qu.: -0.721	
Median : -3.324	Median : -0.033	Median : -0.133	
Mean : 1.674	Mean : 0.452	Mean : 0.286	
3rd Qu.: 79.643	3rd Qu.: 0.940	3rd Qu.: 0.584	
Max. : 154.952	Max. : 54.998	Max. : 55.628	
kurtosis_yaw_dumbbell	skewness_roll_dumbbell	skewness_pitch_dumbbell	
Mode:logical	Min. : -7.384	Min. : -7.447	
NA's:19622	1st Qu.: -0.581	1st Qu.: -0.526	
	Median : -0.076	Median : -0.091	
	Mean : -0.115	Mean : -0.035	
	3rd Qu.: 0.400	3rd Qu.: 0.505	
	Max. : 1.958	Max. : 3.769	
skewness_yaw_dumbbell	max_roll_dumbbell	max_pitch_dumbbell	
Mode:logical	Min. : -70.10	Min. : -112.90	
NA's:19622	1st Qu.: -27.15	1st Qu.: -66.70	
	Median : 14.85	Median : 40.05	
	Mean : 13.76	Mean : 32.75	
	3rd Qu.: 50.58	3rd Qu.: 133.22	
	Max. : 137.00	Max. : 155.00	
max_yaw_dumbbell	min_roll_dumbbell	min_pitch_dumbbell	min_yaw_dumbbell
Min. : -2.20	Min. : -149.60	Min. : -147.00	Min. : -2.20
1st Qu.: -0.70	1st Qu.: -59.67	1st Qu.: -91.80	1st Qu.: -0.70
Median : 0.00	Median : -43.55	Median : -66.15	Median : 0.00
Mean : 0.45	Mean : -41.24	Mean : -33.18	Mean : 0.45
3rd Qu.: 0.90	3rd Qu.: -25.20	3rd Qu.: 21.20	3rd Qu.: 0.90
Max. : 55.00	Max. : 73.20	Max. : 120.90	Max. : 55.00
amplitude_roll_dumbbell	amplitude_pitch_dumbbell	amplitude_yaw_dumbbell	
Min. : 0.00	Min. : 0.00	Min. : 0	
1st Qu.: 14.97	1st Qu.: 17.06	1st Qu.: 0	
Median : 35.05	Median : 41.73	Median : 0	
Mean : 55.00	Mean : 65.93	Mean : 0	
3rd Qu.: 81.04	3rd Qu.: 99.55	3rd Qu.: 0	
Max. : 256.48	Max. : 273.59	Max. : 0	
total_accel_dumbbell	var_accel_dumbbell	avg_roll_dumbbell	
Min. : 0.00	Min. : 0.000	Min. : -128.96	
1st Qu.: 4.00	1st Qu.: 0.378	1st Qu.: -12.33	
Median : 10.00	Median : 1.000	Median : 48.23	
Mean : 13.72	Mean : 4.388	Mean : 23.86	
3rd Qu.: 19.00	3rd Qu.: 3.434	3rd Qu.: 64.37	
Max. : 58.00	Max. : 230.428	Max. : 125.99	



stddev_roll_dumbbell	var_roll_dumbbell	avg_pitch_dumbbell	
Min. : 0.000	Min. : 0.00	Min. : -70.73	
1st Qu.: 4.639	1st Qu.: 21.52	1st Qu.: -42.00	
Median : 12.204	Median : 148.95	Median : -19.91	
Mean : 20.761	Mean : 1020.27	Mean : -12.33	
3rd Qu.: 26.356	3rd Qu.: 694.65	3rd Qu.: 13.21	
Max. : 123.778	Max. : 15321.01	Max. : 94.28	
stddev_pitch_dumbbell	var_pitch_dumbbell	avg_yaw_dumbbell	
Min. : 0.000	Min. : 0.00	Min. : -117.950	
1st Qu.: 3.482	1st Qu.: 12.12	1st Qu.: -76.696	
Median : 8.089	Median : 65.44	Median : -4.505	
Mean : 13.147	Mean : 350.31	Mean : 0.202	
3rd Qu.: 19.238	3rd Qu.: 370.11	3rd Qu.: 71.234	
Max. : 82.680	Max. : 6836.02	Max. : 134.905	
stddev_yaw_dumbbell	var_yaw_dumbbell	gyros_dumbbell_x	
Min. : 0.000	Min. : 0.00	Min. : -204.0000	
1st Qu.: 3.885	1st Qu.: 15.09	1st Qu.: -0.0300	
Median : 10.264	Median : 105.35	Median : 0.1300	
Mean : 16.647	Mean : 589.84	Mean : 0.1611	
3rd Qu.: 24.674	3rd Qu.: 608.79	3rd Qu.: 0.3500	
Max. : 107.088	Max. : 11467.91	Max. : 2.2200	
gyros_dumbbell_y	gyros_dumbbell_z	accel_dumbbell_x	accel_dumbbell_y
Min. : -2.10000	Min. : -2.380	Min. : -419.00	Min. : -189.00
1st Qu.: -0.14000	1st Qu.: -0.310	1st Qu.: -50.00	1st Qu.: -8.00
Median : 0.03000	Median : -0.130	Median : -8.00	Median : 41.50
Mean : 0.04606	Mean : -0.129	Mean : -28.62	Mean : 52.63
3rd Qu.: 0.21000	3rd Qu.: 0.030	3rd Qu.: 11.00	3rd Qu.: 111.00
Max. : 52.00000	Max. : 317.000	Max. : 235.00	Max. : 315.00
accel_dumbbell_z	magnet_dumbbell_x	magnet_dumbbell_y	magnet_dumbbell_z
Min. : -334.00	Min. : -643.0	Min. : -3600	Min. : -262.00
1st Qu.: -142.00	1st Qu.: -535.0	1st Qu.: 231	1st Qu.: -45.00
Median : -1.00	Median : -479.0	Median : 311	Median : 13.00
Mean : -38.32	Mean : -328.5	Mean : 221	Mean : 46.05
3rd Qu.: 38.00	3rd Qu.: -304.0	3rd Qu.: 390	3rd Qu.: 95.00
Max. : 318.00	Max. : 592.0	Max. : 633	Max. : 452.00
roll_forearm	pitch_forearm	yaw_forearm	
Min. : -180.0000	Min. : -72.50	Min. : -180.00	
1st Qu.: -0.7375	1st Qu.: 0.00	1st Qu.: -68.60	
Median : 21.7000	Median : 9.24	Median : 0.00	
Mean : 33.8265	Mean : 10.71	Mean : 19.21	
3rd Qu.: 140.0000	3rd Qu.: 28.40	3rd Qu.: 110.00	
Max. : 180.0000	Max. : 89.80	Max. : 180.00	
kurtosis_roll_forearm	kurtosis_pitch_forearm	kurtosis_yaw_forearm	
Min. : -1.879	Min. : -2.098	Mode:logical	
1st Qu.: -1.398	1st Qu.: -1.376	NA's:19622	
Median : -1.119	Median : -0.890		
Mean : -0.689	Mean : 0.419		
3rd Qu.: -0.618	3rd Qu.: 0.054		
Max. : 40.060	Max. : 33.626		
skewness_roll_forearm	skewness_pitch_forearm	skewness_yaw_forearm	
Min. : -2.297	Min. : -5.241	Mode:logical	
1st Qu.: -0.402	1st Qu.: -0.881	NA's:19622	
Median : 0.003	Median : -0.156		
Mean : -0.009	Mean : -0.223		
3rd Qu.: 0.370	3rd Qu.: 0.514		
Max. : 5.856	Max. : 4.464		
max_roll_forearm	max_pitch_forearm	max_yaw_forearm	min_roll_forearm

Min. : -66.60	Min. : -151.00	Min. : -1.900	Min. : -72.500
1st Qu.: 0.00	1st Qu.: 0.00	1st Qu.: -1.400	1st Qu.: -6.075
Median : 26.80	Median : 113.00	Median : -1.100	Median : 0.000
Mean : 24.49	Mean : 81.49	Mean : -0.689	Mean : -0.167
3rd Qu.: 45.95	3rd Qu.: 174.75	3rd Qu.: -0.600	3rd Qu.: 12.075
Max. : 89.80	Max. : 180.00	Max. : 40.100	Max. : 62.100
min_pitch_forearm	min_yaw_forearm	amplitude_roll_forearm	
Min. : -180.00	Min. : -1.900	Min. : 0.000	
1st Qu.: -175.00	1st Qu.: -1.400	1st Qu.: 1.125	
Median : -61.00	Median : -1.100	Median : 17.770	
Mean : -57.57	Mean : -0.689	Mean : 24.653	
3rd Qu.: 0.00	3rd Qu.: -0.600	3rd Qu.: 39.875	
Max. : 167.00	Max. : 40.100	Max. : 126.000	
amplitude_pitch_forearm	amplitude_yaw_forearm	total_accel_forearm	
Min. : 0.0	Min. : 0	Min. : 0.00	
1st Qu.: 2.0	1st Qu.: 0	1st Qu.: 29.00	
Median : 83.7	Median : 0	Median : 36.00	
Mean : 139.1	Mean : 0	Mean : 34.72	
3rd Qu.: 350.0	3rd Qu.: 0	3rd Qu.: 41.00	
Max. : 360.0	Max. : 0	Max. : 108.00	
var_accel_forearm	avg_roll_forearm	stddev_roll_forearm	
Min. : 0.000	Min. : -177.234	Min. : 0.000	
1st Qu.: 6.759	1st Qu.: -0.909	1st Qu.: 0.428	
Median : 21.165	Median : 11.172	Median : 8.030	
Mean : 33.502	Mean : 33.165	Mean : 41.986	
3rd Qu.: 51.240	3rd Qu.: 107.132	3rd Qu.: 85.373	
Max. : 172.606	Max. : 177.256	Max. : 179.171	
var_roll_forearm	avg_pitch_forearm	stddev_pitch_forearm	
Min. : 0.00	Min. : -68.17	Min. : 0.000	
1st Qu.: 0.18	1st Qu.: 0.00	1st Qu.: 0.336	
Median : 64.48	Median : 12.02	Median : 5.516	
Mean : 5274.10	Mean : 11.79	Mean : 7.977	
3rd Qu.: 7289.08	3rd Qu.: 28.48	3rd Qu.: 12.866	
Max. : 32102.24	Max. : 72.09	Max. : 47.745	
var_pitch_forearm	avg_yaw_forearm	stddev_yaw_forearm	var_yaw_forearm
Min. : 0.000	Min. : -155.06	Min. : 0.000	Min. : 0.00
1st Qu.: 0.113	1st Qu.: -26.26	1st Qu.: 0.524	1st Qu.: 0.27
Median : 30.425	Median : 0.00	Median : 24.743	Median : 612.21
Mean : 139.593	Mean : 18.00	Mean : 44.854	Mean : 4639.85
3rd Qu.: 165.532	3rd Qu.: 85.79	3rd Qu.: 85.817	3rd Qu.: 7368.41
Max. : 2279.617	Max. : 169.24	Max. : 197.508	Max. : 39009.33
gyros_forearm_x	gyros_forearm_y	gyros_forearm_z	accel_forearm_x
Min. : -22.000	Min. : -7.02000	Min. : -8.0900	Min. : -498.00
1st Qu.: -0.220	1st Qu.: -1.46000	1st Qu.: -0.1800	1st Qu.: -178.00
Median : 0.050	Median : 0.03000	Median : 0.0800	Median : -57.00
Mean : 0.158	Mean : 0.07517	Mean : 0.1512	Mean : -61.65
3rd Qu.: 0.560	3rd Qu.: 1.62000	3rd Qu.: 0.4900	3rd Qu.: 76.00
Max. : 3.970	Max. : 311.00000	Max. : 231.0000	Max. : 477.00
accel_forearm_y	accel_forearm_z	magnet_forearm_x	magnet_forearm_y
Min. : -632.0	Min. : -446.00	Min. : -1280.0	Min. : -896.0
1st Qu.: 57.0	1st Qu.: -182.00	1st Qu.: -616.0	1st Qu.: 2.0
Median : 201.0	Median : -39.00	Median : -378.0	Median : 591.0
Mean : 163.7	Mean : -55.29	Mean : -312.6	Mean : 380.1
3rd Qu.: 312.0	3rd Qu.: 26.00	3rd Qu.: -73.0	3rd Qu.: 737.0
Max. : 923.0	Max. : 291.00	Max. : 672.0	Max. : 1480.0
magnet_forearm_z	classe		
Min. : -973.0	A:5580		

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1st Qu.: 191.0    B:3797
Median : 511.0    C:3422
Mean   : 393.6    D:3216
3rd Qu.: 653.0    E:3607
Max.    :1090.0
[ reached getOption("max.print") -- omitted 1 row ]
> summary(validation)
      X      user_name raw_timestamp_part_1 raw_timestamp_part_2
Min.   : 1.00   adelmo   :1   Min.   :1.322e+09   Min.   : 36553
1st Qu.: 5.75   carlitos:3   1st Qu.:1.323e+09   1st Qu.:268655
Median :10.50   charles :1   Median :1.323e+09   Median :530706
Mean   :10.50   eurico  :4   Mean   :1.323e+09   Mean   :512167
3rd Qu.:15.25   jeremy  :8   3rd Qu.:1.323e+09   3rd Qu.:787738
Max.    :20.00   pedro   :3   Max.    :1.323e+09   Max.    :920315
      cvtd_timestamp new_window  num_window  roll_belt
30/11/2011 17:11:4    no:20    Min.   : 48.0   Min.   : -5.9200
05/12/2011 11:24:3                    1st Qu.:250.0   1st Qu.:  0.9075
30/11/2011 17:12:3                    Median :384.5   Median :  1.1100
05/12/2011 14:23:2                    Mean   :379.6   Mean   : 31.3055
28/11/2011 14:14:2                    3rd Qu.:467.0   3rd Qu.: 32.5050
02/12/2011 13:33:1                    Max.    :859.0   Max.    :129.0000
      pitch_belt      yaw_belt      total_accel_belt kurtosis_roll_belt
Min.   : -41.600   Min.   : -93.70   Min.   : 2.00   Mode:logical
1st Qu.:  3.013   1st Qu.: -88.62   1st Qu.: 3.00   NA's:20
Median :  4.655   Median : -87.85   Median : 4.00
Mean   :  5.824   Mean   : -59.30   Mean   : 7.55
3rd Qu.:  6.135   3rd Qu.: -63.50   3rd Qu.: 8.00
Max.    : 27.800   Max.    :162.00   Max.    :21.00
kurtosis_pitch_belt kurtosis_yaw_belt skewness_roll_belt
Mode:logical        Mode:logical        Mode:logical
NA's:20              NA's:20              NA's:20

skewness_roll_belt.1 skewness_yaw_belt max_roll_belt  max_pitch_belt
Mode:logical          Mode:logical          Mode:logical  Mode:logical
NA's:20                NA's:20                NA's:20      NA's:20

max_yaw_belt  min_roll_belt  min_pitch_belt min_yaw_belt
Mode:logical  Mode:logical  Mode:logical  Mode:logical
NA's:20       NA's:20       NA's:20       NA's:20

amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
Mode:logical        Mode:logical        Mode:logical
NA's:20              NA's:20              NA's:20

var_total_accel_belt avg_roll_belt  stddev_roll_belt var_roll_belt

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Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

avg_pitch_belt	stddev_pitch_belt	var_pitch_belt	avg_yaw_belt
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

stddev_yaw_belt	var_yaw_belt	gyros_belt_x	gyros_belt_y
Mode:logical	Mode:logical	Min. :-0.500	Min. :-0.050
NA's:20	NA's:20	1st Qu.: -0.070	1st Qu.: -0.005
		Median : 0.020	Median : 0.000
		Mean :-0.045	Mean : 0.010
		3rd Qu.: 0.070	3rd Qu.: 0.020
		Max. : 0.240	Max. : 0.110

gyros_belt_z	accel_belt_x	accel_belt_y	accel_belt_z
Min. :-0.4800	Min. :-48.00	Min. :-16.00	Min. :-187.00
1st Qu.: -0.1375	1st Qu.: -19.00	1st Qu.: 2.00	1st Qu.: -24.00
Median : -0.0250	Median : -13.00	Median : 4.50	Median : 27.00
Mean :-0.1005	Mean : -13.50	Mean : 18.35	Mean : -17.60
3rd Qu.: 0.0000	3rd Qu.: -8.75	3rd Qu.: 25.50	3rd Qu.: 38.25
Max. : 0.0500	Max. : 46.00	Max. : 72.00	Max. : 49.00

magnet_belt_x	magnet_belt_y	magnet_belt_z	roll_arm
Min. :-13.00	Min. :566.0	Min. :-426.0	Min. :-137.00
1st Qu.: 5.50	1st Qu.:578.5	1st Qu.: -398.5	1st Qu.: 0.00
Median : 33.50	Median :600.5	Median : -313.5	Median : 0.00
Mean : 35.15	Mean :601.5	Mean : -346.9	Mean : 16.42
3rd Qu.: 46.25	3rd Qu.:631.2	3rd Qu.: -305.0	3rd Qu.: 71.53
Max. :169.00	Max. :638.0	Max. : -291.0	Max. : 152.00

pitch_arm	yaw_arm	total_accel_arm	var_accel_arm
Min. :-63.800	Min. :-167.00	Min. : 3.00	Mode:logical
1st Qu.: -9.188	1st Qu.: -60.15	1st Qu.:20.25	NA's:20
Median : 0.000	Median : 0.00	Median :29.50	
Mean : -3.950	Mean : -2.80	Mean :26.40	
3rd Qu.: 3.465	3rd Qu.: 25.50	3rd Qu.:33.25	
Max. : 55.000	Max. : 178.00	Max. :44.00	

avg_roll_arm	stddev_roll_arm	var_roll_arm	avg_pitch_arm
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

stddev_pitch_arm	var_pitch_arm	avg_yaw_arm	stddev_yaw_arm
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

var_yaw_arm	gyros_arm_x	gyros_arm_y	gyros_arm_z
Mode:logical	Min. :-3.710	Min. :-2.0900	Min. :-0.6900

NA's:20	1st Qu.: -0.645	1st Qu.: -0.6350	1st Qu.: -0.1800	
	Median : 0.020	Median : -0.0400	Median : -0.0250	
	Mean : 0.077	Mean : -0.1595	Mean : 0.1205	
	3rd Qu.: 1.248	3rd Qu.: 0.2175	3rd Qu.: 0.5650	
	Max. : 3.660	Max. : 1.8500	Max. : 1.1300	
accel_arm_x	accel_arm_y	accel_arm_z	magnet_arm_x	
Min. : -341.0	Min. : -65.00	Min. : -404.00	Min. : -428.00	
1st Qu.: -277.0	1st Qu.: 52.25	1st Qu.: -128.50	1st Qu.: -373.75	
Median : -194.5	Median : 112.00	Median : -83.50	Median : -265.00	
Mean : -134.6	Mean : 103.10	Mean : -87.85	Mean : -38.95	
3rd Qu.: 5.5	3rd Qu.: 168.25	3rd Qu.: -27.25	3rd Qu.: 250.50	
Max. : 106.0	Max. : 245.00	Max. : 93.00	Max. : 750.00	
magnet_arm_y	magnet_arm_z	kurtosis_roll_arm	kurtosis_pitch_arm	
Min. : -307.0	Min. : -499.0	Mode:logical	Mode:logical	
1st Qu.: 205.2	1st Qu.: 403.0	NA's:20	NA's:20	
Median : 291.0	Median : 476.5			
Mean : 239.4	Mean : 369.8			
3rd Qu.: 358.8	3rd Qu.: 517.0			
Max. : 474.0	Max. : 633.0			
kurtosis_yaw_arm	skewness_roll_arm	skewness_pitch_arm	skewness_yaw_arm	
Mode:logical	Mode:logical	Mode:logical	Mode:logical	
NA's:20	NA's:20	NA's:20	NA's:20	
max_roll_arm	max_pitch_arm	max_yaw_arm	min_roll_arm	min_pitch_arm
Mode:logical	Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20	NA's:20
min_yaw_arm	amplitude_roll_arm	amplitude_pitch_arm	amplitude_yaw_arm	
Mode:logical	Mode:logical	Mode:logical	Mode:logical	
NA's:20	NA's:20	NA's:20	NA's:20	
roll_dumbbell	pitch_dumbbell	yaw_dumbbell		
Min. : -111.118	Min. : -54.97	Min. : -103.3200		
1st Qu.: 7.494	1st Qu.: -51.89	1st Qu.: -75.2809		
Median : 50.403	Median : -40.81	Median : -8.2863		
Mean : 33.760	Mean : -19.47	Mean : -0.9385		
3rd Qu.: 58.129	3rd Qu.: 16.12	3rd Qu.: 55.8335		
Max. : 123.984	Max. : 96.87	Max. : 132.2337		
kurtosis_roll_dumbbell	kurtosis_pitch_dumbbell	kurtosis_yaw_dumbbell		
Mode:logical	Mode:logical	Mode:logical		
NA's:20	NA's:20	NA's:20		
skewness_roll_dumbbell	skewness_pitch_dumbbell	skewness_yaw_dumbbell		
Mode:logical	Mode:logical	Mode:logical		
NA's:20	NA's:20	NA's:20		

max_roll_dumbbell	max_pitch_dumbbell	max_yaw_dumbbell	min_roll_dumbbell
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

min_pitch_dumbbell	min_yaw_dumbbell	amplitude_roll_dumbbell
Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20

amplitude_pitch_dumbbell	amplitude_yaw_dumbbell	total_accel_dumbbell
Mode:logical	Mode:logical	Min. : 1.0
NA's:20	NA's:20	1st Qu.: 7.0
		Median :15.5
		Mean :17.2
		3rd Qu.:29.0
		Max. :31.0

var_accel_dumbbell	avg_roll_dumbbell	stddev_roll_dumbbell
Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20

var_roll_dumbbell	avg_pitch_dumbbell	stddev_pitch_dumbbell
Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20

var_pitch_dumbbell	avg_yaw_dumbbell	stddev_yaw_dumbbell	var_yaw_dumbbell
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

gyros_dumbbell_x	gyros_dumbbell_y	gyros_dumbbell_z	accel_dumbbell_x
Min. :-1.0300	Min. :-1.1100	Min. :-1.180	Min. :-159.00
1st Qu.: 0.1600	1st Qu.: -0.2100	1st Qu.: -0.485	1st Qu.: -140.25
Median : 0.3600	Median : 0.0150	Median : -0.280	Median : -19.00
Mean : 0.2690	Mean : 0.0605	Mean : -0.266	Mean : -47.60
3rd Qu.: 0.4625	3rd Qu.: 0.1450	3rd Qu.: -0.165	3rd Qu.: 15.75
Max. : 1.0600	Max. : 1.9100	Max. : 1.100	Max. : 185.00
accel_dumbbell_y	accel_dumbbell_z	magnet_dumbbell_x	magnet_dumbbell_y
Min. :-30.00	Min. :-221.0	Min. :-576.0	Min. :-558.0
1st Qu.: 5.75	1st Qu.: -192.2	1st Qu.: -528.0	1st Qu.: 259.5
Median : 71.50	Median : -3.0	Median : -508.5	Median : 316.0

Mean : 70.55	Mean : -60.0	Mean : -304.2	Mean : 189.3
3rd Qu.:151.25	3rd Qu.: 76.5	3rd Qu.: -317.0	3rd Qu.: 348.2
Max. :166.00	Max. : 100.0	Max. : 523.0	Max. : 403.0
magnet_dumbbell_z	roll_forearm	pitch_forearm	yaw_forearm
Min. :-164.00	Min. :-176.00	Min. :-63.500	Min. :-168.000
1st Qu.: -33.00	1st Qu.: -40.25	1st Qu.: -11.457	1st Qu.: -93.375
Median : 49.50	Median : 94.20	Median : 8.830	Median : -19.250
Mean : 71.40	Mean : 38.66	Mean : 7.099	Mean : 2.195
3rd Qu.: 96.25	3rd Qu.: 143.25	3rd Qu.: 28.500	3rd Qu.: 104.500
Max. : 368.00	Max. : 176.00	Max. : 59.300	Max. : 159.000
kurtosis_roll_forearm	kurtosis_pitch_forearm	kurtosis_yaw_forearm	
Mode:logical	Mode:logical	Mode:logical	
NA's:20	NA's:20	NA's:20	

skewness_roll_forearm	skewness_pitch_forearm	skewness_yaw_forearm
Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20

max_roll_forearm	max_pitch_forearm	max_yaw_forearm	min_roll_forearm
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

min_pitch_forearm	min_yaw_forearm	amplitude_roll_forearm
Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20

amplitude_pitch_forearm	amplitude_yaw_forearm	total_accel_forearm	
Mode:logical	Mode:logical	Min. :21.00	
NA's:20	NA's:20	1st Qu.:24.00	
		Median :32.50	
		Mean :32.05	
		3rd Qu.:36.75	
		Max. :47.00	
var_accel_forearm	avg_roll_forearm	stddev_roll_forearm	var_roll_forearm
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

avg_pitch_forearm	stddev_pitch_forearm	var_pitch_forearm	avg_yaw_forearm
Mode:logical	Mode:logical	Mode:logical	Mode:logical
NA's:20	NA's:20	NA's:20	NA's:20

stddev_yaw_forearm	var_yaw_forearm	gyros_forearm_x	gyros_forearm_y
Mode:logical	Mode:logical	Min. :-1.0600	Min. :-5.9700
NA's:20	NA's:20	1st Qu.: -0.5850	1st Qu.: -1.2875
		Median : 0.0200	Median : 0.0350
		Mean :-0.0200	Mean :-0.0415
		3rd Qu.: 0.2925	3rd Qu.: 2.0475
		Max. : 1.3800	Max. : 4.2600

gyros_forearm_z	accel_forearm_x	accel_forearm_y	accel_forearm_z
Min. :-1.2600	Min. :-212.0	Min. :-331.0	Min. :-282.0
1st Qu.: -0.0975	1st Qu.: -114.8	1st Qu.: 8.5	1st Qu.: -199.0
Median : 0.2300	Median : 86.0	Median : 138.0	Median : -148.5
Mean : 0.2610	Mean : 38.8	Mean : 125.3	Mean : -93.7
3rd Qu.: 0.7625	3rd Qu.: 166.2	3rd Qu.: 268.0	3rd Qu.: -31.0
Max. : 1.8000	Max. : 232.0	Max. : 406.0	Max. : 179.0

magnet_forearm_x	magnet_forearm_y	magnet_forearm_z	problem_id
Min. :-714.0	Min. :-787.0	Min. :-32.0	Min. : 1.00
1st Qu.: -427.2	1st Qu.: -328.8	1st Qu.: 275.2	1st Qu.: 5.75
Median : -189.5	Median : 487.0	Median : 491.5	Median : 10.50
Mean :-159.2	Mean : 191.8	Mean : 460.2	Mean : 10.50
3rd Qu.: 41.5	3rd Qu.: 720.8	3rd Qu.: 661.5	3rd Qu.: 15.25
Max. : 532.0	Max. : 800.0	Max. : 884.0	Max. : 20.00

```

[ reached getOption("max.print") -- omitted 1 row ]
> dim(data)
[1] 19622 160
> dim(validation)
[1] 20 160
> #Remove unnecessary columns
> # first 7 columns don't contain useful info
> data <- data[,-seq(1:7)]
> validation <- validation[,-seq(1:7)]
>
> #Remove columns with NAs This reduces the amount of predictors to 53
> # select columns that don't have NAs
> indexNA <- as.vector(sapply(data[,1:152],function(x) {length(which(is.na(x)
))!=0})))
> data <- data[,!indexNA]
> validation <- validation[,!indexNA]
> # set last (classe) and prior (- classe) column index
> #last <- as.numeric(ncol(data))
> #prior <- last - 1
>
> # set variables to numerics for correlation check, except the "classe"
> for (i in 1:prior) {
+   data[,i] <- as.numeric(data[,i])
+   validation[,i] <- as.numeric(validation[,i])
+ }
>
> #check the correlations
> cor.check <- cor(data[, -c(last)])
> diag(cor.check) <- 0
> plot( levelplot(cor.check, main = "Correlation matrix for all WLE features i
n training set",
+         scales=list(x=list(rot=90), cex=1.0)))
> # find the highly correlated variables
> highly.cor <- findCorrelation(cor(data[, -c(last)]), cutoff=0.9)

```



```

> # pre process variables
> preObj <-preProcess(data[,1:prior],method=c('knnImpute', 'center', 'scale'))
> dataPrep <- predict(preObj, data[,1:prior])
> dataPrep$classe <- data$classe
>
> valPrep <-predict(preObj,validation[,1:prior])
> valPrep$problem_id <- validation$problem_id
> # test near zero variance
> myDataNZV <- nearZeroVar(dataPrep, saveMetrics=TRUE)
> if (any(myDataNZV$nzv)) nzv else message("No variables with near zero variance")
No variables with near zero variance
> dataPrep <- dataPrep[,myDataNZV$nzv==FALSE]
> valPrep <- valPrep[,myDataNZV$nzv==FALSE]
> # split dataset into training and test set
> inTrain <- createDataPartition(y=dataPrep$classe, p=0.7, list=FALSE )
> training <- dataPrep[inTrain,]
> testing <- dataPrep[-inTrain,]
> # set seed for reproducibility
> set.seed(12345)
>
> # get the best mtry
> bestmtry <- tuneRF(training[-last],training$classe, ntreeTry=100,
+                   stepFactor=1.5,improve=0.01, trace=TRUE, plot=TRUE, dobest=FALSE)
mtry = 7   OOB error = 0.65%
Searching left ...
mtry = 5   OOB error = 0.72%
-0.1123596 0.01
Searching right ...
mtry = 10   OOB error = 0.55%
0.1573034 0.01
mtry = 15   OOB error = 0.57%
-0.04 0.01
>
> mtry <- bestmtry[as.numeric(which.min(bestmtry[, "OOBError"])), "mtry"]
>
> # Model 1: RandomForest
> wle.rf <-randomForest(classe~.,data=training, mtry=mtry, ntree=501,
+                      keep.forest=TRUE, proximity=TRUE,
+                      importance=TRUE,test=testing)
> # plot the Out of bag error estimates
> layout(matrix(c(1,2),nrow=1), width=c(4,1))
> par(mar=c(5,4,4,0)) #No margin on the right side
> plot(wle.rf, log="y", main ="Out-of-bag (OOB) error estimate per Number of Trees")
> par(mar=c(5,0,4,2)) #No margin on the left side
> plot(c(0,1),type="n", axes=F, xlab="", ylab="")
> legend("top", colnames(wle.rf$err.rate),col=1:6,cex=0.8,fill=1:6)
> # plot the accuracy and Gini
> varImpPlot(wle.rf, main="Mean Decrease of Accuracy and Gini per variable")
> # MDSplot (we couldn't execute this due to lack of memory)
> MDSplot(wle.rf, training$classe)
Error: cannot allocate vector of size 1.4 Gb
> # results with training set
> predict1 <- predict(wle.rf, newdata=training)

```

```
> confusionMatrix(predict1,training$classe)
Confusion Matrix and Statistics
```

	Reference				
Prediction	A	B	C	D	E
A	3906	0	0	0	0
B	0	2658	0	0	0
C	0	0	2396	0	0
D	0	0	0	2252	0
E	0	0	0	0	2525

Overall Statistics

```
Accuracy : 1
95% CI : (0.9997, 1)
No Information Rate : 0.2843
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	1.0000	1.0000	1.0000	1.0000
Specificity	1.0000	1.0000	1.0000	1.0000	1.0000
Pos Pred Value	1.0000	1.0000	1.0000	1.0000	1.0000
Neg Pred Value	1.0000	1.0000	1.0000	1.0000	1.0000
Prevalence	0.2843	0.1935	0.1744	0.1639	0.1838
Detection Rate	0.2843	0.1935	0.1744	0.1639	0.1838
Detection Prevalence	0.2843	0.1935	0.1744	0.1639	0.1838
Balanced Accuracy	1.0000	1.0000	1.0000	1.0000	1.0000

```
> #Confusion Matrix and Statistics
> # results with test set
> predict2 <- predict(wle.rf, newdata=testing)
> confusionMatrix(predict2,testing$classe)
Confusion Matrix and Statistics
```

	Reference				
Prediction	A	B	C	D	E
A	1673	11	0	0	0
B	1	1125	8	0	0
C	0	3	1016	8	1
D	0	0	2	955	2
E	0	0	0	1	1079

Overall Statistics

```
Accuracy : 0.9937
95% CI : (0.9913, 0.9956)
No Information Rate : 0.2845
P-Value [Acc > NIR] : < 2.2e-16
```

```
Kappa : 0.992
McNemar's Test P-Value : NA
```

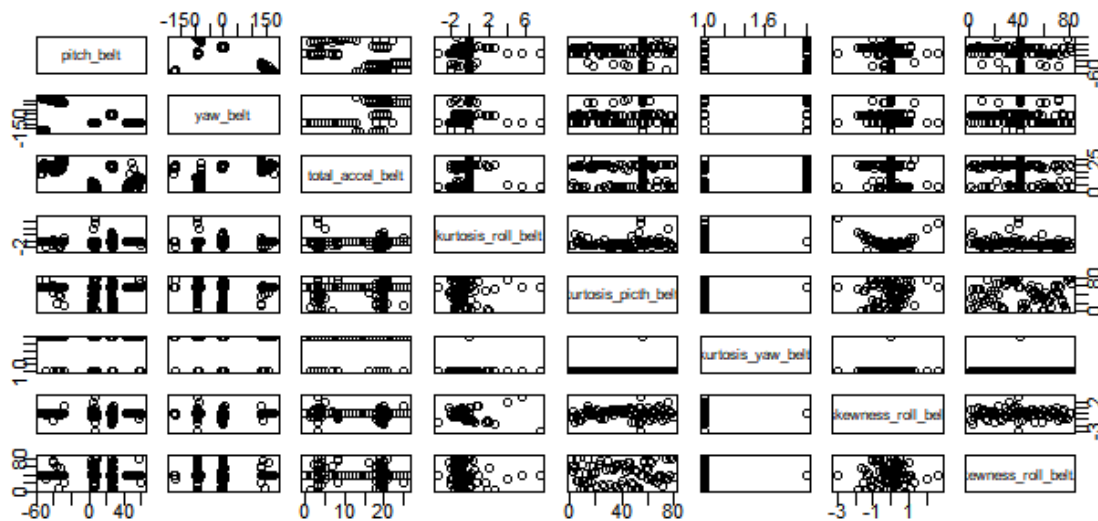
Statistics by Class:

	Class: A	Class: B	Class: C	Class: D	Class: E
Sensitivity	0.9994	0.9877	0.9903	0.9907	0.9972
Specificity	0.9974	0.9981	0.9975	0.9992	0.9998
Pos Pred Value	0.9935	0.9921	0.9883	0.9958	0.9991
Neg Pred Value	0.9998	0.9971	0.9979	0.9982	0.9994
Prevalence	0.2845	0.1935	0.1743	0.1638	0.1839
Detection Rate	0.2843	0.1912	0.1726	0.1623	0.1833
Detection Prevalence	0.2862	0.1927	0.1747	0.1630	0.1835
Balanced Accuracy	0.9984	0.9929	0.9939	0.9949	0.9985

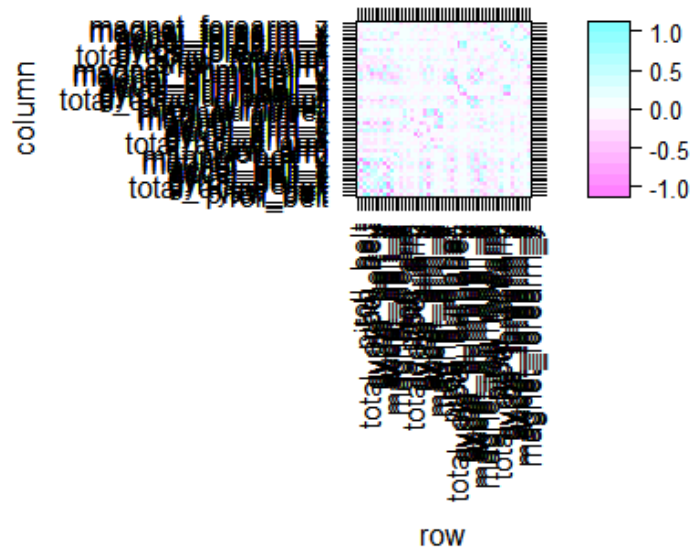
```

>
> # Confusion Matrix and Statistics
> #Train Model 2: Decision Tree
> # Model 2: Decision Tree
> dt <- rpart(classe ~ ., data=training, method="class")
>
> # fancyRpartPlot works for small trees, but not for ours
> fancyRpartPlot(dt)
Warning message:
labs do not fit even at cex 0.15, there may be some overplotting

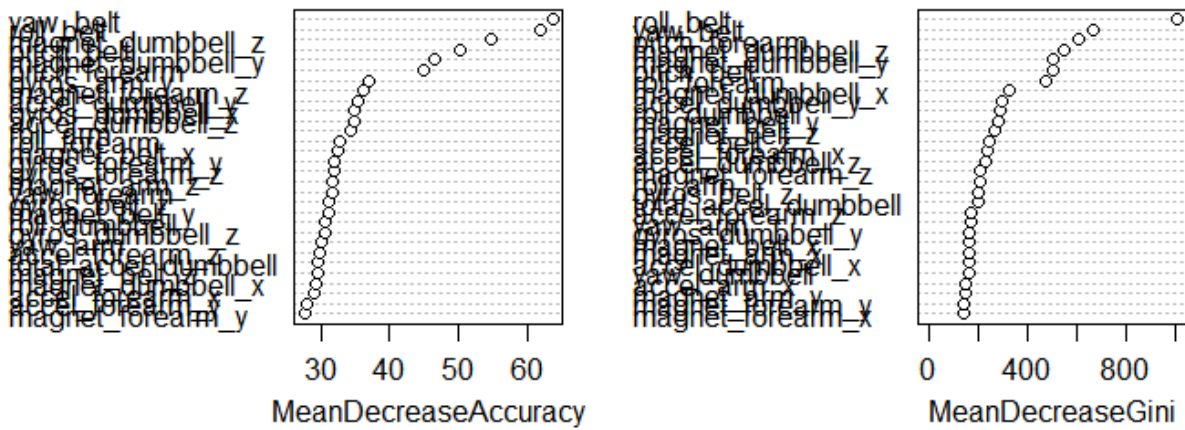
```



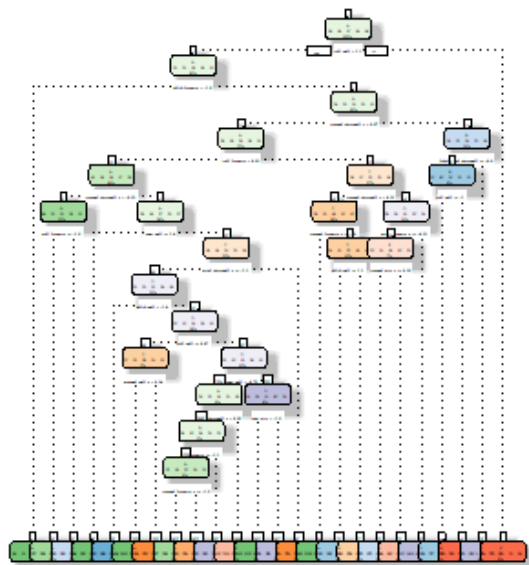
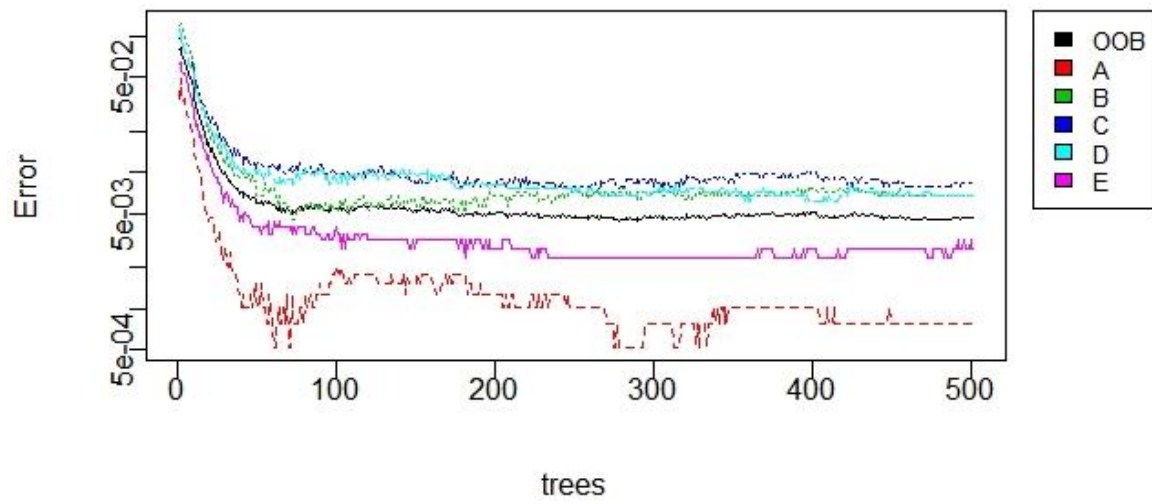
## Correlation matrix for all WLE features in training set



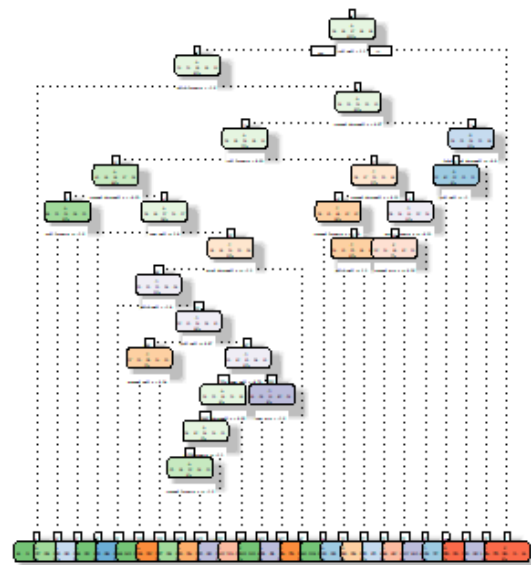
## Mean Decrease of Accuracy and Gini per variable



## Out-of-bag (OOB) error estimate per Number of Tree:



Rattle 2018-Aug-06 11:54:59 Seshan



Rattle 2018-Aug-06 13:22:43 Seshan