MachineLearningPR

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Machine Learning Peer Reviewed Project BACKGROUND Using devices such as Jawbone Up, Nike FuelBand, and Fitbit it is now possible to collect a large amount of data about personal activity relatively inexpensively. These type of devices are part of the quantified self movement - a group of enthusiasts who take measurements about themselves regularly to improve their health, to find patterns in their behavior, or because they are tech geeks. One thing that people regularly do is quantify how much of a particular activity they do, but they rarely quantify how well they do it. In this project, your goal will be to use data from accelerometers on the belt, forearm, arm, and dumbell of 6 participants. They were asked to perform barbell lifts correctly and incorrectly in 5 different ways.

In this project, we will be looking at wearables data to try and determine in which way they did the exercise.

The goal of your project is to predict the manner in which they did the exercise. This is the "classe" variable in the training set. You may use any of the other variables to predict with.

First, we'll take a look at how to load the data and format it for analysis

library(caret)

## Warning: package 'caret' was built under R version 3.4.2

## Loading required package: lattice

## Loading required package: ggplot2

library(randomForest) #Random forest for classification and regression

## Warning: package 'randomForest' was built under R version 3.4.2

## randomForest 4.6-12

## Type rfNews() to see new features/changes/bug fixes.

##   
## Attaching package: 'randomForest'

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

## randomForest 4.6-10  
## Type rfNews() to see new features/changes/bug fixes.  
library(rpart) # Regressive Partitioning and Regression trees  
library(rpart.plot) # Decision Tree plot

## Warning: package 'rpart.plot' was built under R version 3.4.2

trainingdata<- read.csv("C:/Users/Manuel/Desktop/Coursera/MachineLearning/pml-training.csv", na.strings = c("NA",""))  
  
  
testingdata<- read.csv("C:/Users/Manuel/Desktop/Coursera/MachineLearning/pml-testing.csv", na.strings= c("NA",""))  
  
  
head(trainingdata)

## X user\_name raw\_timestamp\_part\_1 raw\_timestamp\_part\_2 cvtd\_timestamp  
## 1 1 carlitos 1323084231 788290 05/12/2011 11:23  
## 2 2 carlitos 1323084231 808298 05/12/2011 11:23  
## 3 3 carlitos 1323084231 820366 05/12/2011 11:23  
## 4 4 carlitos 1323084232 120339 05/12/2011 11:23  
## 5 5 carlitos 1323084232 196328 05/12/2011 11:23  
## 6 6 carlitos 1323084232 304277 05/12/2011 11:23  
## new\_window num\_window roll\_belt pitch\_belt yaw\_belt total\_accel\_belt  
## 1 no 11 1.41 8.07 -94.4 3  
## 2 no 11 1.41 8.07 -94.4 3  
## 3 no 11 1.42 8.07 -94.4 3  
## 4 no 12 1.48 8.05 -94.4 3  
## 5 no 12 1.48 8.07 -94.4 3  
## 6 no 12 1.45 8.06 -94.4 3  
## kurtosis\_roll\_belt kurtosis\_picth\_belt kurtosis\_yaw\_belt  
## 1 <NA> <NA> <NA>  
## 2 <NA> <NA> <NA>  
## 3 <NA> <NA> <NA>  
## 4 <NA> <NA> <NA>  
## 5 <NA> <NA> <NA>  
## 6 <NA> <NA> <NA>  
## skewness\_roll\_belt skewness\_roll\_belt.1 skewness\_yaw\_belt max\_roll\_belt  
## 1 <NA> <NA> <NA> NA  
## 2 <NA> <NA> <NA> NA  
## 3 <NA> <NA> <NA> NA  
## 4 <NA> <NA> <NA> NA  
## 5 <NA> <NA> <NA> NA  
## 6 <NA> <NA> <NA> NA  
## max\_picth\_belt max\_yaw\_belt min\_roll\_belt min\_pitch\_belt min\_yaw\_belt  
## 1 NA <NA> NA NA <NA>  
## 2 NA <NA> NA NA <NA>  
## 3 NA <NA> NA NA <NA>  
## 4 NA <NA> NA NA <NA>  
## 5 NA <NA> NA NA <NA>  
## 6 NA <NA> NA NA <NA>  
## amplitude\_roll\_belt amplitude\_pitch\_belt amplitude\_yaw\_belt  
## 1 NA NA <NA>  
## 2 NA NA <NA>  
## 3 NA NA <NA>  
## 4 NA NA <NA>  
## 5 NA NA <NA>  
## 6 NA NA <NA>  
## var\_total\_accel\_belt avg\_roll\_belt stddev\_roll\_belt var\_roll\_belt  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## avg\_pitch\_belt stddev\_pitch\_belt var\_pitch\_belt avg\_yaw\_belt  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## stddev\_yaw\_belt var\_yaw\_belt gyros\_belt\_x gyros\_belt\_y gyros\_belt\_z  
## 1 NA NA 0.00 0.00 -0.02  
## 2 NA NA 0.02 0.00 -0.02  
## 3 NA NA 0.00 0.00 -0.02  
## 4 NA NA 0.02 0.00 -0.03  
## 5 NA NA 0.02 0.02 -0.02  
## 6 NA NA 0.02 0.00 -0.02  
## accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y  
## 1 -21 4 22 -3 599  
## 2 -22 4 22 -7 608  
## 3 -20 5 23 -2 600  
## 4 -22 3 21 -6 604  
## 5 -21 2 24 -6 600  
## 6 -21 4 21 0 603  
## magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm var\_accel\_arm  
## 1 -313 -128 22.5 -161 34 NA  
## 2 -311 -128 22.5 -161 34 NA  
## 3 -305 -128 22.5 -161 34 NA  
## 4 -310 -128 22.1 -161 34 NA  
## 5 -302 -128 22.1 -161 34 NA  
## 6 -312 -128 22.0 -161 34 NA  
## avg\_roll\_arm stddev\_roll\_arm var\_roll\_arm avg\_pitch\_arm stddev\_pitch\_arm  
## 1 NA NA NA NA NA  
## 2 NA NA NA NA NA  
## 3 NA NA NA NA NA  
## 4 NA NA NA NA NA  
## 5 NA NA NA NA NA  
## 6 NA NA NA NA NA  
## var\_pitch\_arm avg\_yaw\_arm stddev\_yaw\_arm var\_yaw\_arm gyros\_arm\_x  
## 1 NA NA NA NA 0.00  
## 2 NA NA NA NA 0.02  
## 3 NA NA NA NA 0.02  
## 4 NA NA NA NA 0.02  
## 5 NA NA NA NA 0.00  
## 6 NA NA NA NA 0.02  
## gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z magnet\_arm\_x  
## 1 0.00 -0.02 -288 109 -123 -368  
## 2 -0.02 -0.02 -290 110 -125 -369  
## 3 -0.02 -0.02 -289 110 -126 -368  
## 4 -0.03 0.02 -289 111 -123 -372  
## 5 -0.03 0.00 -289 111 -123 -374  
## 6 -0.03 0.00 -289 111 -122 -369  
## magnet\_arm\_y magnet\_arm\_z kurtosis\_roll\_arm kurtosis\_picth\_arm  
## 1 337 516 <NA> <NA>  
## 2 337 513 <NA> <NA>  
## 3 344 513 <NA> <NA>  
## 4 344 512 <NA> <NA>  
## 5 337 506 <NA> <NA>  
## 6 342 513 <NA> <NA>  
## kurtosis\_yaw\_arm skewness\_roll\_arm skewness\_pitch\_arm skewness\_yaw\_arm  
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## 2 <NA> <NA> <NA> <NA>  
## 3 <NA> <NA> <NA> <NA>  
## 4 <NA> <NA> <NA> <NA>  
## 5 <NA> <NA> <NA> <NA>  
## 6 <NA> <NA> <NA> <NA>  
## max\_roll\_arm max\_picth\_arm max\_yaw\_arm min\_roll\_arm min\_pitch\_arm  
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## 2 NA NA NA NA NA  
## 3 NA NA NA NA NA  
## 4 NA NA NA NA NA  
## 5 NA NA NA NA NA  
## 6 NA NA NA NA NA  
## min\_yaw\_arm amplitude\_roll\_arm amplitude\_pitch\_arm amplitude\_yaw\_arm  
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## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## roll\_dumbbell pitch\_dumbbell yaw\_dumbbell kurtosis\_roll\_dumbbell  
## 1 13.05217 -70.49400 -84.87394 <NA>  
## 2 13.13074 -70.63751 -84.71065 <NA>  
## 3 12.85075 -70.27812 -85.14078 <NA>  
## 4 13.43120 -70.39379 -84.87363 <NA>  
## 5 13.37872 -70.42856 -84.85306 <NA>  
## 6 13.38246 -70.81759 -84.46500 <NA>  
## kurtosis\_picth\_dumbbell kurtosis\_yaw\_dumbbell skewness\_roll\_dumbbell  
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## 2 <NA> <NA> <NA>  
## 3 <NA> <NA> <NA>  
## 4 <NA> <NA> <NA>  
## 5 <NA> <NA> <NA>  
## 6 <NA> <NA> <NA>  
## skewness\_pitch\_dumbbell skewness\_yaw\_dumbbell max\_roll\_dumbbell  
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## 3 <NA> <NA> NA  
## 4 <NA> <NA> NA  
## 5 <NA> <NA> NA  
## 6 <NA> <NA> NA  
## max\_picth\_dumbbell max\_yaw\_dumbbell min\_roll\_dumbbell min\_pitch\_dumbbell  
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## 2 NA <NA> NA NA  
## 3 NA <NA> NA NA  
## 4 NA <NA> NA NA  
## 5 NA <NA> NA NA  
## 6 NA <NA> NA NA  
## min\_yaw\_dumbbell amplitude\_roll\_dumbbell amplitude\_pitch\_dumbbell  
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## 2 <NA> NA NA  
## 3 <NA> NA NA  
## 4 <NA> NA NA  
## 5 <NA> NA NA  
## 6 <NA> NA NA  
## amplitude\_yaw\_dumbbell total\_accel\_dumbbell var\_accel\_dumbbell  
## 1 <NA> 37 NA  
## 2 <NA> 37 NA  
## 3 <NA> 37 NA  
## 4 <NA> 37 NA  
## 5 <NA> 37 NA  
## 6 <NA> 37 NA  
## avg\_roll\_dumbbell stddev\_roll\_dumbbell var\_roll\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## avg\_pitch\_dumbbell stddev\_pitch\_dumbbell var\_pitch\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## avg\_yaw\_dumbbell stddev\_yaw\_dumbbell var\_yaw\_dumbbell gyros\_dumbbell\_x  
## 1 NA NA NA 0  
## 2 NA NA NA 0  
## 3 NA NA NA 0  
## 4 NA NA NA 0  
## 5 NA NA NA 0  
## 6 NA NA NA 0  
## gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x accel\_dumbbell\_y  
## 1 -0.02 0.00 -234 47  
## 2 -0.02 0.00 -233 47  
## 3 -0.02 0.00 -232 46  
## 4 -0.02 -0.02 -232 48  
## 5 -0.02 0.00 -233 48  
## 6 -0.02 0.00 -234 48  
## accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y magnet\_dumbbell\_z  
## 1 -271 -559 293 -65  
## 2 -269 -555 296 -64  
## 3 -270 -561 298 -63  
## 4 -269 -552 303 -60  
## 5 -270 -554 292 -68  
## 6 -269 -558 294 -66  
## roll\_forearm pitch\_forearm yaw\_forearm kurtosis\_roll\_forearm  
## 1 28.4 -63.9 -153 <NA>  
## 2 28.3 -63.9 -153 <NA>  
## 3 28.3 -63.9 -152 <NA>  
## 4 28.1 -63.9 -152 <NA>  
## 5 28.0 -63.9 -152 <NA>  
## 6 27.9 -63.9 -152 <NA>  
## kurtosis\_picth\_forearm kurtosis\_yaw\_forearm skewness\_roll\_forearm  
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## 2 <NA> <NA> <NA>  
## 3 <NA> <NA> <NA>  
## 4 <NA> <NA> <NA>  
## 5 <NA> <NA> <NA>  
## 6 <NA> <NA> <NA>  
## skewness\_pitch\_forearm skewness\_yaw\_forearm max\_roll\_forearm  
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## 2 <NA> <NA> NA  
## 3 <NA> <NA> NA  
## 4 <NA> <NA> NA  
## 5 <NA> <NA> NA  
## 6 <NA> <NA> NA  
## max\_picth\_forearm max\_yaw\_forearm min\_roll\_forearm min\_pitch\_forearm  
## 1 NA <NA> NA NA  
## 2 NA <NA> NA NA  
## 3 NA <NA> NA NA  
## 4 NA <NA> NA NA  
## 5 NA <NA> NA NA  
## 6 NA <NA> NA NA  
## min\_yaw\_forearm amplitude\_roll\_forearm amplitude\_pitch\_forearm  
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## 2 <NA> NA NA  
## 3 <NA> NA NA  
## 4 <NA> NA NA  
## 5 <NA> NA NA  
## 6 <NA> NA NA  
## amplitude\_yaw\_forearm total\_accel\_forearm var\_accel\_forearm  
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## avg\_roll\_forearm stddev\_roll\_forearm var\_roll\_forearm avg\_pitch\_forearm  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## stddev\_pitch\_forearm var\_pitch\_forearm avg\_yaw\_forearm  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## stddev\_yaw\_forearm var\_yaw\_forearm gyros\_forearm\_x gyros\_forearm\_y  
## 1 NA NA 0.03 0.00  
## 2 NA NA 0.02 0.00  
## 3 NA NA 0.03 -0.02  
## 4 NA NA 0.02 -0.02  
## 5 NA NA 0.02 0.00  
## 6 NA NA 0.02 -0.02  
## gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z  
## 1 -0.02 192 203 -215  
## 2 -0.02 192 203 -216  
## 3 0.00 196 204 -213  
## 4 0.00 189 206 -214  
## 5 -0.02 189 206 -214  
## 6 -0.03 193 203 -215  
## magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z classe  
## 1 -17 654 476 A  
## 2 -18 661 473 A  
## 3 -18 658 469 A  
## 4 -16 658 469 A  
## 5 -17 655 473 A  
## 6 -9 660 478 A

head(testingdata)

## X user\_name raw\_timestamp\_part\_1 raw\_timestamp\_part\_2 cvtd\_timestamp  
## 1 1 pedro 1323095002 868349 05/12/2011 14:23  
## 2 2 jeremy 1322673067 778725 30/11/2011 17:11  
## 3 3 jeremy 1322673075 342967 30/11/2011 17:11  
## 4 4 adelmo 1322832789 560311 02/12/2011 13:33  
## 5 5 eurico 1322489635 814776 28/11/2011 14:13  
## 6 6 jeremy 1322673149 510661 30/11/2011 17:12  
## new\_window num\_window roll\_belt pitch\_belt yaw\_belt total\_accel\_belt  
## 1 no 74 123.00 27.00 -4.75 20  
## 2 no 431 1.02 4.87 -88.90 4  
## 3 no 439 0.87 1.82 -88.50 5  
## 4 no 194 125.00 -41.60 162.00 17  
## 5 no 235 1.35 3.33 -88.60 3  
## 6 no 504 -5.92 1.59 -87.70 4  
## kurtosis\_roll\_belt kurtosis\_picth\_belt kurtosis\_yaw\_belt  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## skewness\_roll\_belt skewness\_roll\_belt.1 skewness\_yaw\_belt max\_roll\_belt  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## max\_picth\_belt max\_yaw\_belt min\_roll\_belt min\_pitch\_belt min\_yaw\_belt  
## 1 NA NA NA NA NA  
## 2 NA NA NA NA NA  
## 3 NA NA NA NA NA  
## 4 NA NA NA NA NA  
## 5 NA NA NA NA NA  
## 6 NA NA NA NA NA  
## amplitude\_roll\_belt amplitude\_pitch\_belt amplitude\_yaw\_belt  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## var\_total\_accel\_belt avg\_roll\_belt stddev\_roll\_belt var\_roll\_belt  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## avg\_pitch\_belt stddev\_pitch\_belt var\_pitch\_belt avg\_yaw\_belt  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## stddev\_yaw\_belt var\_yaw\_belt gyros\_belt\_x gyros\_belt\_y gyros\_belt\_z  
## 1 NA NA -0.50 -0.02 -0.46  
## 2 NA NA -0.06 -0.02 -0.07  
## 3 NA NA 0.05 0.02 0.03  
## 4 NA NA 0.11 0.11 -0.16  
## 5 NA NA 0.03 0.02 0.00  
## 6 NA NA 0.10 0.05 -0.13  
## accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y  
## 1 -38 69 -179 -13 581  
## 2 -13 11 39 43 636  
## 3 1 -1 49 29 631  
## 4 46 45 -156 169 608  
## 5 -8 4 27 33 566  
## 6 -11 -16 38 31 638  
## magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm var\_accel\_arm  
## 1 -382 40.7 -27.80 178 10 NA  
## 2 -309 0.0 0.00 0 38 NA  
## 3 -312 0.0 0.00 0 44 NA  
## 4 -304 -109.0 55.00 -142 25 NA  
## 5 -418 76.1 2.76 102 29 NA  
## 6 -291 0.0 0.00 0 14 NA  
## avg\_roll\_arm stddev\_roll\_arm var\_roll\_arm avg\_pitch\_arm stddev\_pitch\_arm  
## 1 NA NA NA NA NA  
## 2 NA NA NA NA NA  
## 3 NA NA NA NA NA  
## 4 NA NA NA NA NA  
## 5 NA NA NA NA NA  
## 6 NA NA NA NA NA  
## var\_pitch\_arm avg\_yaw\_arm stddev\_yaw\_arm var\_yaw\_arm gyros\_arm\_x  
## 1 NA NA NA NA -1.65  
## 2 NA NA NA NA -1.17  
## 3 NA NA NA NA 2.10  
## 4 NA NA NA NA 0.22  
## 5 NA NA NA NA -1.96  
## 6 NA NA NA NA 0.02  
## gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z magnet\_arm\_x  
## 1 0.48 -0.18 16 38 93 -326  
## 2 0.85 -0.43 -290 215 -90 -325  
## 3 -1.36 1.13 -341 245 -87 -264  
## 4 -0.51 0.92 -238 -57 6 -173  
## 5 0.79 -0.54 -197 200 -30 -170  
## 6 0.05 -0.07 -26 130 -19 396  
## magnet\_arm\_y magnet\_arm\_z kurtosis\_roll\_arm kurtosis\_picth\_arm  
## 1 385 481 NA NA  
## 2 447 434 NA NA  
## 3 474 413 NA NA  
## 4 257 633 NA NA  
## 5 275 617 NA NA  
## 6 176 516 NA NA  
## kurtosis\_yaw\_arm skewness\_roll\_arm skewness\_pitch\_arm skewness\_yaw\_arm  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## max\_roll\_arm max\_picth\_arm max\_yaw\_arm min\_roll\_arm min\_pitch\_arm  
## 1 NA NA NA NA NA  
## 2 NA NA NA NA NA  
## 3 NA NA NA NA NA  
## 4 NA NA NA NA NA  
## 5 NA NA NA NA NA  
## 6 NA NA NA NA NA  
## min\_yaw\_arm amplitude\_roll\_arm amplitude\_pitch\_arm amplitude\_yaw\_arm  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## roll\_dumbbell pitch\_dumbbell yaw\_dumbbell kurtosis\_roll\_dumbbell  
## 1 -17.73748 24.96085 126.23596 NA  
## 2 54.47761 -53.69758 -75.51480 NA  
## 3 57.07031 -51.37303 -75.20287 NA  
## 4 43.10927 -30.04885 -103.32003 NA  
## 5 -101.38396 -53.43952 -14.19542 NA  
## 6 62.18750 -50.55595 -71.12063 NA  
## kurtosis\_picth\_dumbbell kurtosis\_yaw\_dumbbell skewness\_roll\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## skewness\_pitch\_dumbbell skewness\_yaw\_dumbbell max\_roll\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## max\_picth\_dumbbell max\_yaw\_dumbbell min\_roll\_dumbbell min\_pitch\_dumbbell  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## min\_yaw\_dumbbell amplitude\_roll\_dumbbell amplitude\_pitch\_dumbbell  
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## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## amplitude\_yaw\_dumbbell total\_accel\_dumbbell var\_accel\_dumbbell  
## 1 NA 9 NA  
## 2 NA 31 NA  
## 3 NA 29 NA  
## 4 NA 18 NA  
## 5 NA 4 NA  
## 6 NA 29 NA  
## avg\_roll\_dumbbell stddev\_roll\_dumbbell var\_roll\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## avg\_pitch\_dumbbell stddev\_pitch\_dumbbell var\_pitch\_dumbbell  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## avg\_yaw\_dumbbell stddev\_yaw\_dumbbell var\_yaw\_dumbbell gyros\_dumbbell\_x  
## 1 NA NA NA 0.64  
## 2 NA NA NA 0.34  
## 3 NA NA NA 0.39  
## 4 NA NA NA 0.10  
## 5 NA NA NA 0.29  
## 6 NA NA NA -0.59  
## gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x accel\_dumbbell\_y  
## 1 0.06 -0.61 21 -15  
## 2 0.05 -0.71 -153 155  
## 3 0.14 -0.34 -141 155  
## 4 -0.02 0.05 -51 72  
## 5 -0.47 -0.46 -18 -30  
## 6 0.80 1.10 -138 166  
## accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y magnet\_dumbbell\_z  
## 1 81 523 -528 -56  
## 2 -205 -502 388 -36  
## 3 -196 -506 349 41  
## 4 -148 -576 238 53  
## 5 -5 -424 252 312  
## 6 -186 -543 262 96  
## roll\_forearm pitch\_forearm yaw\_forearm kurtosis\_roll\_forearm  
## 1 141 49.30 156.0 NA  
## 2 109 -17.60 106.0 NA  
## 3 131 -32.60 93.0 NA  
## 4 0 0.00 0.0 NA  
## 5 -176 -2.16 -47.9 NA  
## 6 150 1.46 89.7 NA  
## kurtosis\_picth\_forearm kurtosis\_yaw\_forearm skewness\_roll\_forearm  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## skewness\_pitch\_forearm skewness\_yaw\_forearm max\_roll\_forearm  
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## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## max\_picth\_forearm max\_yaw\_forearm min\_roll\_forearm min\_pitch\_forearm  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## min\_yaw\_forearm amplitude\_roll\_forearm amplitude\_pitch\_forearm  
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## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## amplitude\_yaw\_forearm total\_accel\_forearm var\_accel\_forearm  
## 1 NA 33 NA  
## 2 NA 39 NA  
## 3 NA 34 NA  
## 4 NA 43 NA  
## 5 NA 24 NA  
## 6 NA 43 NA  
## avg\_roll\_forearm stddev\_roll\_forearm var\_roll\_forearm avg\_pitch\_forearm  
## 1 NA NA NA NA  
## 2 NA NA NA NA  
## 3 NA NA NA NA  
## 4 NA NA NA NA  
## 5 NA NA NA NA  
## 6 NA NA NA NA  
## stddev\_pitch\_forearm var\_pitch\_forearm avg\_yaw\_forearm  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA  
## stddev\_yaw\_forearm var\_yaw\_forearm gyros\_forearm\_x gyros\_forearm\_y  
## 1 NA NA 0.74 -3.34  
## 2 NA NA 1.12 -2.78  
## 3 NA NA 0.18 -0.79  
## 4 NA NA 1.38 0.69  
## 5 NA NA -0.75 3.10  
## 6 NA NA -0.88 4.26  
## gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z  
## 1 -0.59 -110 267 -149  
## 2 -0.18 212 297 -118  
## 3 0.28 154 271 -129  
## 4 1.80 -92 406 -39  
## 5 0.80 131 -93 172  
## 6 1.35 230 322 -144  
## magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z problem\_id  
## 1 -714 419 617 1  
## 2 -237 791 873 2  
## 3 -51 698 783 3  
## 4 -233 783 521 4  
## 5 375 -787 91 5  
## 6 -300 800 884 6

#Then, We try to clear all the NA values in the data  
trainingdata<- trainingdata[,colSums(is.na(trainingdata))==0]  
testingdata<-testingdata[,colSums(is.na(testingdata))==0]  
  
#Also, since we will not be using all of the data. We eliminate the data that we will not be using  
trainingdata <-trainingdata[,-c(1:7)]  
testingdata <-testingdata[,-c(1:7)]

After formatting, we take a look at the newly formatted data:

dim(trainingdata)

## [1] 19622 53

dim(testingdata)

## [1] 20 53

head(trainingdata)

## roll\_belt pitch\_belt yaw\_belt total\_accel\_belt gyros\_belt\_x gyros\_belt\_y  
## 1 1.41 8.07 -94.4 3 0.00 0.00  
## 2 1.41 8.07 -94.4 3 0.02 0.00  
## 3 1.42 8.07 -94.4 3 0.00 0.00  
## 4 1.48 8.05 -94.4 3 0.02 0.00  
## 5 1.48 8.07 -94.4 3 0.02 0.02  
## 6 1.45 8.06 -94.4 3 0.02 0.00  
## gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x  
## 1 -0.02 -21 4 22 -3  
## 2 -0.02 -22 4 22 -7  
## 3 -0.02 -20 5 23 -2  
## 4 -0.03 -22 3 21 -6  
## 5 -0.02 -21 2 24 -6  
## 6 -0.02 -21 4 21 0  
## magnet\_belt\_y magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm  
## 1 599 -313 -128 22.5 -161 34  
## 2 608 -311 -128 22.5 -161 34  
## 3 600 -305 -128 22.5 -161 34  
## 4 604 -310 -128 22.1 -161 34  
## 5 600 -302 -128 22.1 -161 34  
## 6 603 -312 -128 22.0 -161 34  
## gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z  
## 1 0.00 0.00 -0.02 -288 109 -123  
## 2 0.02 -0.02 -0.02 -290 110 -125  
## 3 0.02 -0.02 -0.02 -289 110 -126  
## 4 0.02 -0.03 0.02 -289 111 -123  
## 5 0.00 -0.03 0.00 -289 111 -123  
## 6 0.02 -0.03 0.00 -289 111 -122  
## magnet\_arm\_x magnet\_arm\_y magnet\_arm\_z roll\_dumbbell pitch\_dumbbell  
## 1 -368 337 516 13.05217 -70.49400  
## 2 -369 337 513 13.13074 -70.63751  
## 3 -368 344 513 12.85075 -70.27812  
## 4 -372 344 512 13.43120 -70.39379  
## 5 -374 337 506 13.37872 -70.42856  
## 6 -369 342 513 13.38246 -70.81759  
## yaw\_dumbbell total\_accel\_dumbbell gyros\_dumbbell\_x gyros\_dumbbell\_y  
## 1 -84.87394 37 0 -0.02  
## 2 -84.71065 37 0 -0.02  
## 3 -85.14078 37 0 -0.02  
## 4 -84.87363 37 0 -0.02  
## 5 -84.85306 37 0 -0.02  
## 6 -84.46500 37 0 -0.02  
## gyros\_dumbbell\_z accel\_dumbbell\_x accel\_dumbbell\_y accel\_dumbbell\_z  
## 1 0.00 -234 47 -271  
## 2 0.00 -233 47 -269  
## 3 0.00 -232 46 -270  
## 4 -0.02 -232 48 -269  
## 5 0.00 -233 48 -270  
## 6 0.00 -234 48 -269  
## magnet\_dumbbell\_x magnet\_dumbbell\_y magnet\_dumbbell\_z roll\_forearm  
## 1 -559 293 -65 28.4  
## 2 -555 296 -64 28.3  
## 3 -561 298 -63 28.3  
## 4 -552 303 -60 28.1  
## 5 -554 292 -68 28.0  
## 6 -558 294 -66 27.9  
## pitch\_forearm yaw\_forearm total\_accel\_forearm gyros\_forearm\_x  
## 1 -63.9 -153 36 0.03  
## 2 -63.9 -153 36 0.02  
## 3 -63.9 -152 36 0.03  
## 4 -63.9 -152 36 0.02  
## 5 -63.9 -152 36 0.02  
## 6 -63.9 -152 36 0.02  
## gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y  
## 1 0.00 -0.02 192 203  
## 2 0.00 -0.02 192 203  
## 3 -0.02 0.00 196 204  
## 4 -0.02 0.00 189 206  
## 5 0.00 -0.02 189 206  
## 6 -0.02 -0.03 193 203  
## accel\_forearm\_z magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z  
## 1 -215 -17 654 476  
## 2 -216 -18 661 473  
## 3 -213 -18 658 469  
## 4 -214 -16 658 469  
## 5 -214 -17 655 473  
## 6 -215 -9 660 478  
## classe  
## 1 A  
## 2 A  
## 3 A  
## 4 A  
## 5 A  
## 6 A

head(testingdata)

## roll\_belt pitch\_belt yaw\_belt total\_accel\_belt gyros\_belt\_x gyros\_belt\_y  
## 1 123.00 27.00 -4.75 20 -0.50 -0.02  
## 2 1.02 4.87 -88.90 4 -0.06 -0.02  
## 3 0.87 1.82 -88.50 5 0.05 0.02  
## 4 125.00 -41.60 162.00 17 0.11 0.11  
## 5 1.35 3.33 -88.60 3 0.03 0.02  
## 6 -5.92 1.59 -87.70 4 0.10 0.05  
## gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x  
## 1 -0.46 -38 69 -179 -13  
## 2 -0.07 -13 11 39 43  
## 3 0.03 1 -1 49 29  
## 4 -0.16 46 45 -156 169  
## 5 0.00 -8 4 27 33  
## 6 -0.13 -11 -16 38 31  
## magnet\_belt\_y magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm total\_accel\_arm  
## 1 581 -382 40.7 -27.80 178 10  
## 2 636 -309 0.0 0.00 0 38  
## 3 631 -312 0.0 0.00 0 44  
## 4 608 -304 -109.0 55.00 -142 25  
## 5 566 -418 76.1 2.76 102 29  
## 6 638 -291 0.0 0.00 0 14  
## gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x accel\_arm\_y accel\_arm\_z  
## 1 -1.65 0.48 -0.18 16 38 93  
## 2 -1.17 0.85 -0.43 -290 215 -90  
## 3 2.10 -1.36 1.13 -341 245 -87  
## 4 0.22 -0.51 0.92 -238 -57 6  
## 5 -1.96 0.79 -0.54 -197 200 -30  
## 6 0.02 0.05 -0.07 -26 130 -19  
## magnet\_arm\_x magnet\_arm\_y magnet\_arm\_z roll\_dumbbell pitch\_dumbbell  
## 1 -326 385 481 -17.73748 24.96085  
## 2 -325 447 434 54.47761 -53.69758  
## 3 -264 474 413 57.07031 -51.37303  
## 4 -173 257 633 43.10927 -30.04885  
## 5 -170 275 617 -101.38396 -53.43952  
## 6 396 176 516 62.18750 -50.55595  
## yaw\_dumbbell total\_accel\_dumbbell gyros\_dumbbell\_x gyros\_dumbbell\_y  
## 1 126.23596 9 0.64 0.06  
## 2 -75.51480 31 0.34 0.05  
## 3 -75.20287 29 0.39 0.14  
## 4 -103.32003 18 0.10 -0.02  
## 5 -14.19542 4 0.29 -0.47  
## 6 -71.12063 29 -0.59 0.80  
## gyros\_dumbbell\_z accel\_dumbbell\_x accel\_dumbbell\_y accel\_dumbbell\_z  
## 1 -0.61 21 -15 81  
## 2 -0.71 -153 155 -205  
## 3 -0.34 -141 155 -196  
## 4 0.05 -51 72 -148  
## 5 -0.46 -18 -30 -5  
## 6 1.10 -138 166 -186  
## magnet\_dumbbell\_x magnet\_dumbbell\_y magnet\_dumbbell\_z roll\_forearm  
## 1 523 -528 -56 141  
## 2 -502 388 -36 109  
## 3 -506 349 41 131  
## 4 -576 238 53 0  
## 5 -424 252 312 -176  
## 6 -543 262 96 150  
## pitch\_forearm yaw\_forearm total\_accel\_forearm gyros\_forearm\_x  
## 1 49.30 156.0 33 0.74  
## 2 -17.60 106.0 39 1.12  
## 3 -32.60 93.0 34 0.18  
## 4 0.00 0.0 43 1.38  
## 5 -2.16 -47.9 24 -0.75  
## 6 1.46 89.7 43 -0.88  
## gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y  
## 1 -3.34 -0.59 -110 267  
## 2 -2.78 -0.18 212 297  
## 3 -0.79 0.28 154 271  
## 4 0.69 1.80 -92 406  
## 5 3.10 0.80 131 -93  
## 6 4.26 1.35 230 322  
## accel\_forearm\_z magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z  
## 1 -149 -714 419 617  
## 2 -118 -237 791 873  
## 3 -129 -51 698 783  
## 4 -39 -233 783 521  
## 5 172 375 -787 91  
## 6 -144 -300 800 884  
## problem\_id  
## 1 1  
## 2 2  
## 3 3  
## 4 4  
## 5 5  
## 6 6

summary(trainingdata)

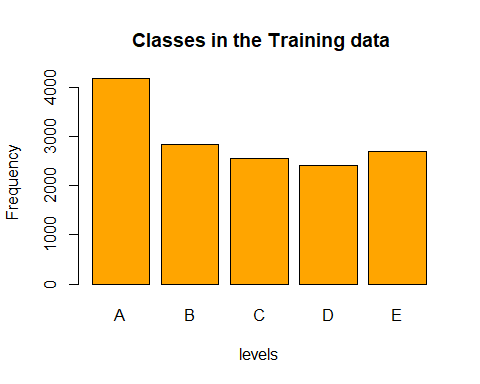
## roll\_belt pitch\_belt yaw\_belt total\_accel\_belt  
## Min. :-28.90 Min. :-55.8000 Min. :-180.00 Min. : 0.00   
## 1st Qu.: 1.10 1st Qu.: 1.7600 1st Qu.: -88.30 1st Qu.: 3.00   
## Median :113.00 Median : 5.2800 Median : -13.00 Median :17.00   
## Mean : 64.41 Mean : 0.3053 Mean : -11.21 Mean :11.31   
## 3rd Qu.:123.00 3rd Qu.: 14.9000 3rd Qu.: 12.90 3rd Qu.:18.00   
## Max. :162.00 Max. : 60.3000 Max. : 179.00 Max. :29.00   
## gyros\_belt\_x gyros\_belt\_y gyros\_belt\_z   
## Min. :-1.040000 Min. :-0.64000 Min. :-1.4600   
## 1st Qu.:-0.030000 1st Qu.: 0.00000 1st Qu.:-0.2000   
## Median : 0.030000 Median : 0.02000 Median :-0.1000   
## Mean :-0.005592 Mean : 0.03959 Mean :-0.1305   
## 3rd Qu.: 0.110000 3rd Qu.: 0.11000 3rd Qu.:-0.0200   
## Max. : 2.220000 Max. : 0.64000 Max. : 1.6200   
## accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x   
## Min. :-120.000 Min. :-69.00 Min. :-275.00 Min. :-52.0   
## 1st Qu.: -21.000 1st Qu.: 3.00 1st Qu.:-162.00 1st Qu.: 9.0   
## Median : -15.000 Median : 35.00 Median :-152.00 Median : 35.0   
## Mean : -5.595 Mean : 30.15 Mean : -72.59 Mean : 55.6   
## 3rd Qu.: -5.000 3rd Qu.: 61.00 3rd Qu.: 27.00 3rd Qu.: 59.0   
## Max. : 85.000 Max. :164.00 Max. : 105.00 Max. :485.0   
## magnet\_belt\_y magnet\_belt\_z roll\_arm pitch\_arm   
## Min. :354.0 Min. :-623.0 Min. :-180.00 Min. :-88.800   
## 1st Qu.:581.0 1st Qu.:-375.0 1st Qu.: -31.77 1st Qu.:-25.900   
## Median :601.0 Median :-320.0 Median : 0.00 Median : 0.000   
## Mean :593.7 Mean :-345.5 Mean : 17.83 Mean : -4.612   
## 3rd Qu.:610.0 3rd Qu.:-306.0 3rd Qu.: 77.30 3rd Qu.: 11.200   
## Max. :673.0 Max. : 293.0 Max. : 180.00 Max. : 88.500   
## yaw\_arm total\_accel\_arm gyros\_arm\_x gyros\_arm\_y   
## Min. :-180.0000 Min. : 1.00 Min. :-6.37000 Min. :-3.4400   
## 1st Qu.: -43.1000 1st Qu.:17.00 1st Qu.:-1.33000 1st Qu.:-0.8000   
## Median : 0.0000 Median :27.00 Median : 0.08000 Median :-0.2400   
## Mean : -0.6188 Mean :25.51 Mean : 0.04277 Mean :-0.2571   
## 3rd Qu.: 45.8750 3rd Qu.:33.00 3rd Qu.: 1.57000 3rd Qu.: 0.1400   
## Max. : 180.0000 Max. :66.00 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 roll\_dumbbell   
## Min. :-584.0 Min. :-392.0 Min. :-597.0 Min. :-153.71   
## 1st Qu.:-300.0 1st Qu.: -9.0 1st Qu.: 131.2 1st Qu.: -18.49   
## Median : 289.0 Median : 202.0 Median : 444.0 Median : 48.17   
## Mean : 191.7 Mean : 156.6 Mean : 306.5 Mean : 23.84   
## 3rd Qu.: 637.0 3rd Qu.: 323.0 3rd Qu.: 545.0 3rd Qu.: 67.61   
## Max. : 782.0 Max. : 583.0 Max. : 694.0 Max. : 153.55   
## pitch\_dumbbell yaw\_dumbbell total\_accel\_dumbbell  
## Min. :-149.59 Min. :-150.871 Min. : 0.00   
## 1st Qu.: -40.89 1st Qu.: -77.644 1st Qu.: 4.00   
## Median : -20.96 Median : -3.324 Median :10.00   
## Mean : -10.78 Mean : 1.674 Mean :13.72   
## 3rd Qu.: 17.50 3rd Qu.: 79.643 3rd Qu.:19.00   
## Max. : 149.40 Max. : 154.952 Max. :58.00   
## gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z   
## Min. :-204.0000 Min. :-2.10000 Min. : -2.380   
## 1st Qu.: -0.0300 1st Qu.:-0.14000 1st Qu.: -0.310   
## Median : 0.1300 Median : 0.03000 Median : -0.130   
## Mean : 0.1611 Mean : 0.04606 Mean : -0.129   
## 3rd Qu.: 0.3500 3rd Qu.: 0.21000 3rd Qu.: 0.030   
## Max. : 2.2200 Max. :52.00000 Max. :317.000   
## accel\_dumbbell\_x accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x  
## Min. :-419.00 Min. :-189.00 Min. :-334.00 Min. :-643.0   
## 1st Qu.: -50.00 1st Qu.: -8.00 1st Qu.:-142.00 1st Qu.:-535.0   
## Median : -8.00 Median : 41.50 Median : -1.00 Median :-479.0   
## Mean : -28.62 Mean : 52.63 Mean : -38.32 Mean :-328.5   
## 3rd Qu.: 11.00 3rd Qu.: 111.00 3rd Qu.: 38.00 3rd Qu.:-304.0   
## Max. : 235.00 Max. : 315.00 Max. : 318.00 Max. : 592.0   
## magnet\_dumbbell\_y magnet\_dumbbell\_z roll\_forearm pitch\_forearm   
## Min. :-3600 Min. :-262.00 Min. :-180.0000 Min. :-72.50   
## 1st Qu.: 231 1st Qu.: -45.00 1st Qu.: -0.7375 1st Qu.: 0.00   
## Median : 311 Median : 13.00 Median : 21.7000 Median : 9.24   
## Mean : 221 Mean : 46.05 Mean : 33.8265 Mean : 10.71   
## 3rd Qu.: 390 3rd Qu.: 95.00 3rd Qu.: 140.0000 3rd Qu.: 28.40   
## Max. : 633 Max. : 452.00 Max. : 180.0000 Max. : 89.80   
## yaw\_forearm total\_accel\_forearm gyros\_forearm\_x   
## Min. :-180.00 Min. : 0.00 Min. :-22.000   
## 1st Qu.: -68.60 1st Qu.: 29.00 1st Qu.: -0.220   
## Median : 0.00 Median : 36.00 Median : 0.050   
## Mean : 19.21 Mean : 34.72 Mean : 0.158   
## 3rd Qu.: 110.00 3rd Qu.: 41.00 3rd Qu.: 0.560   
## Max. : 180.00 Max. :108.00 Max. : 3.970   
## gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y   
## Min. : -7.02000 Min. : -8.0900 Min. :-498.00 Min. :-632.0   
## 1st Qu.: -1.46000 1st Qu.: -0.1800 1st Qu.:-178.00 1st Qu.: 57.0   
## Median : 0.03000 Median : 0.0800 Median : -57.00 Median : 201.0   
## Mean : 0.07517 Mean : 0.1512 Mean : -61.65 Mean : 163.7   
## 3rd Qu.: 1.62000 3rd Qu.: 0.4900 3rd Qu.: 76.00 3rd Qu.: 312.0   
## Max. :311.00000 Max. :231.0000 Max. : 477.00 Max. : 923.0   
## accel\_forearm\_z magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z  
## Min. :-446.00 Min. :-1280.0 Min. :-896.0 Min. :-973.0   
## 1st Qu.:-182.00 1st Qu.: -616.0 1st Qu.: 2.0 1st Qu.: 191.0   
## Median : -39.00 Median : -378.0 Median : 591.0 Median : 511.0   
## Mean : -55.29 Mean : -312.6 Mean : 380.1 Mean : 393.6   
## 3rd Qu.: 26.00 3rd Qu.: -73.0 3rd Qu.: 737.0 3rd Qu.: 653.0   
## Max. : 291.00 Max. : 672.0 Max. :1480.0 Max. :1090.0   
## classe   
## A:5580   
## B:3797   
## C:3422   
## D:3216   
## E:3607   
##

summary(testingdata)

## roll\_belt pitch\_belt yaw\_belt total\_accel\_belt  
## Min. : -5.9200 Min. :-41.600 Min. :-93.70 Min. : 2.00   
## 1st Qu.: 0.9075 1st Qu.: 3.013 1st Qu.:-88.62 1st Qu.: 3.00   
## Median : 1.1100 Median : 4.655 Median :-87.85 Median : 4.00   
## Mean : 31.3055 Mean : 5.824 Mean :-59.30 Mean : 7.55   
## 3rd Qu.: 32.5050 3rd Qu.: 6.135 3rd Qu.:-63.50 3rd Qu.: 8.00   
## Max. :129.0000 Max. : 27.800 Max. :162.00 Max. :21.00   
## gyros\_belt\_x gyros\_belt\_y gyros\_belt\_z accel\_belt\_x   
## Min. :-0.500 Min. :-0.050 Min. :-0.4800 Min. :-48.00   
## 1st Qu.:-0.070 1st Qu.:-0.005 1st Qu.:-0.1375 1st Qu.:-19.00   
## Median : 0.020 Median : 0.000 Median :-0.0250 Median :-13.00   
## Mean :-0.045 Mean : 0.010 Mean :-0.1005 Mean :-13.50   
## 3rd Qu.: 0.070 3rd Qu.: 0.020 3rd Qu.: 0.0000 3rd Qu.: -8.75   
## Max. : 0.240 Max. : 0.110 Max. : 0.0500 Max. : 46.00   
## accel\_belt\_y accel\_belt\_z magnet\_belt\_x magnet\_belt\_y   
## Min. :-16.00 Min. :-187.00 Min. :-13.00 Min. :566.0   
## 1st Qu.: 2.00 1st Qu.: -24.00 1st Qu.: 5.50 1st Qu.:578.5   
## Median : 4.50 Median : 27.00 Median : 33.50 Median :600.5   
## Mean : 18.35 Mean : -17.60 Mean : 35.15 Mean :601.5   
## 3rd Qu.: 25.50 3rd Qu.: 38.25 3rd Qu.: 46.25 3rd Qu.:631.2   
## Max. : 72.00 Max. : 49.00 Max. :169.00 Max. :638.0   
## magnet\_belt\_z roll\_arm pitch\_arm yaw\_arm   
## Min. :-426.0 Min. :-137.00 Min. :-63.800 Min. :-167.00   
## 1st Qu.:-398.5 1st Qu.: 0.00 1st Qu.: -9.188 1st Qu.: -60.15   
## Median :-313.5 Median : 0.00 Median : 0.000 Median : 0.00   
## Mean :-346.9 Mean : 16.42 Mean : -3.950 Mean : -2.80   
## 3rd Qu.:-305.0 3rd Qu.: 71.53 3rd Qu.: 3.465 3rd Qu.: 25.50   
## Max. :-291.0 Max. : 152.00 Max. : 55.000 Max. : 178.00   
## total\_accel\_arm gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z   
## Min. : 3.00 Min. :-3.710 Min. :-2.0900 Min. :-0.6900   
## 1st Qu.:20.25 1st Qu.:-0.645 1st Qu.:-0.6350 1st Qu.:-0.1800   
## Median :29.50 Median : 0.020 Median :-0.0400 Median :-0.0250   
## Mean :26.40 Mean : 0.077 Mean :-0.1595 Mean : 0.1205   
## 3rd Qu.:33.25 3rd Qu.: 1.248 3rd Qu.: 0.2175 3rd Qu.: 0.5650   
## Max. :44.00 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 roll\_dumbbell pitch\_dumbbell   
## Min. :-307.0 Min. :-499.0 Min. :-111.118 Min. :-54.97   
## 1st Qu.: 205.2 1st Qu.: 403.0 1st Qu.: 7.494 1st Qu.:-51.89   
## Median : 291.0 Median : 476.5 Median : 50.403 Median :-40.81   
## Mean : 239.4 Mean : 369.8 Mean : 33.760 Mean :-19.47   
## 3rd Qu.: 358.8 3rd Qu.: 517.0 3rd Qu.: 58.129 3rd Qu.: 16.12   
## Max. : 474.0 Max. : 633.0 Max. : 123.984 Max. : 96.87   
## yaw\_dumbbell total\_accel\_dumbbell gyros\_dumbbell\_x   
## Min. :-103.3200 Min. : 1.0 Min. :-1.0300   
## 1st Qu.: -75.2809 1st Qu.: 7.0 1st Qu.: 0.1600   
## Median : -8.2863 Median :15.5 Median : 0.3600   
## Mean : -0.9385 Mean :17.2 Mean : 0.2690   
## 3rd Qu.: 55.8335 3rd Qu.:29.0 3rd Qu.: 0.4625   
## Max. : 132.2337 Max. :31.0 Max. : 1.0600   
## gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x accel\_dumbbell\_y  
## Min. :-1.1100 Min. :-1.180 Min. :-159.00 Min. :-30.00   
## 1st Qu.:-0.2100 1st Qu.:-0.485 1st Qu.:-140.25 1st Qu.: 5.75   
## Median : 0.0150 Median :-0.280 Median : -19.00 Median : 71.50   
## Mean : 0.0605 Mean :-0.266 Mean : -47.60 Mean : 70.55   
## 3rd Qu.: 0.1450 3rd Qu.:-0.165 3rd Qu.: 15.75 3rd Qu.:151.25   
## Max. : 1.9100 Max. : 1.100 Max. : 185.00 Max. :166.00   
## accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y magnet\_dumbbell\_z  
## Min. :-221.0 Min. :-576.0 Min. :-558.0 Min. :-164.00   
## 1st Qu.:-192.2 1st Qu.:-528.0 1st Qu.: 259.5 1st Qu.: -33.00   
## Median : -3.0 Median :-508.5 Median : 316.0 Median : 49.50   
## Mean : -60.0 Mean :-304.2 Mean : 189.3 Mean : 71.40   
## 3rd Qu.: 76.5 3rd Qu.:-317.0 3rd Qu.: 348.2 3rd Qu.: 96.25   
## Max. : 100.0 Max. : 523.0 Max. : 403.0 Max. : 368.00   
## roll\_forearm pitch\_forearm yaw\_forearm   
## Min. :-176.00 Min. :-63.500 Min. :-168.000   
## 1st Qu.: -40.25 1st Qu.:-11.457 1st Qu.: -93.375   
## Median : 94.20 Median : 8.830 Median : -19.250   
## Mean : 38.66 Mean : 7.099 Mean : 2.195   
## 3rd Qu.: 143.25 3rd Qu.: 28.500 3rd Qu.: 104.500   
## Max. : 176.00 Max. : 59.300 Max. : 159.000   
## total\_accel\_forearm gyros\_forearm\_x gyros\_forearm\_y gyros\_forearm\_z   
## Min. :21.00 Min. :-1.0600 Min. :-5.9700 Min. :-1.2600   
## 1st Qu.:24.00 1st Qu.:-0.5850 1st Qu.:-1.2875 1st Qu.:-0.0975   
## Median :32.50 Median : 0.0200 Median : 0.0350 Median : 0.2300   
## Mean :32.05 Mean :-0.0200 Mean :-0.0415 Mean : 0.2610   
## 3rd Qu.:36.75 3rd Qu.: 0.2925 3rd Qu.: 2.0475 3rd Qu.: 0.7625   
## Max. :47.00 Max. : 1.3800 Max. : 4.2600 Max. : 1.8000   
## accel\_forearm\_x accel\_forearm\_y accel\_forearm\_z magnet\_forearm\_x  
## Min. :-212.0 Min. :-331.0 Min. :-282.0 Min. :-714.0   
## 1st Qu.:-114.8 1st Qu.: 8.5 1st Qu.:-199.0 1st Qu.:-427.2   
## Median : 86.0 Median : 138.0 Median :-148.5 Median :-189.5   
## Mean : 38.8 Mean : 125.3 Mean : -93.7 Mean :-159.2   
## 3rd Qu.: 166.2 3rd Qu.: 268.0 3rd Qu.: -31.0 3rd Qu.: 41.5   
## Max. : 232.0 Max. : 406.0 Max. : 179.0 Max. : 532.0   
## magnet\_forearm\_y magnet\_forearm\_z problem\_id   
## Min. :-787.0 Min. :-32.0 Min. : 1.00   
## 1st Qu.:-328.8 1st Qu.:275.2 1st Qu.: 5.75   
## Median : 487.0 Median :491.5 Median :10.50   
## Mean : 191.8 Mean :460.2 Mean :10.50   
## 3rd Qu.: 720.8 3rd Qu.:661.5 3rd Qu.:15.25   
## Max. : 800.0 Max. :884.0 Max. :20.00

We then set up the data for it to be able to be predicted. Firstly, the data will be run using a decision tree. Followed by a randomForest analysis:

#plotting the decision tree"  
library(rpart)  
library(rpart.plot)  
library(caret)  
library(randomForest)  
#Predicting the data set using "classe"  
  
inTrain<-createDataPartition(y=trainingdata$classe, p = 0.75,list= FALSE)  
training<- trainingdata[inTrain,]  
testing <- trainingdata[-inTrain,]  
  
#graphing training values  
plot(training$classe,col="orange", main=" Classes in the Training data",xlab="levels",ylab="Frequency")

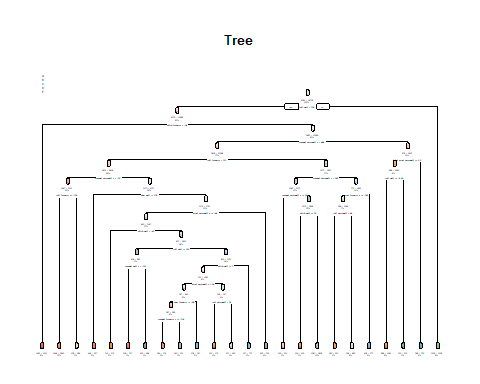


#Using a DecisionTree:  
model1<- rpart( classe ~ ., data= training, method = "class")  
  
pred<- predict(model1, testing, type ="class")  
  
confusionMatrix(pred, testing$classe)

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction A B C D E  
## A 1238 139 25 52 35  
## B 45 583 48 59 89  
## C 24 76 682 122 79  
## D 62 72 47 520 57  
## E 26 79 53 51 641  
##   
## Overall Statistics  
##   
## Accuracy : 0.7471   
## 95% CI : (0.7347, 0.7593)  
## No Information Rate : 0.2845   
## P-Value [Acc > NIR] : < 2.2e-16   
##   
## Kappa : 0.6795   
## Mcnemar's Test P-Value : < 2.2e-16   
##   
## Statistics by Class:  
##   
## Class: A Class: B Class: C Class: D Class: E  
## Sensitivity 0.8875 0.6143 0.7977 0.6468 0.7114  
## Specificity 0.9285 0.9391 0.9257 0.9420 0.9478  
## Pos Pred Value 0.8314 0.7075 0.6938 0.6860 0.7541  
## Neg Pred Value 0.9540 0.9103 0.9559 0.9315 0.9359  
## Prevalence 0.2845 0.1935 0.1743 0.1639 0.1837  
## Detection Rate 0.2524 0.1189 0.1391 0.1060 0.1307  
## Detection Prevalence 0.3036 0.1680 0.2004 0.1546 0.1733  
## Balanced Accuracy 0.9080 0.7767 0.8617 0.7944 0.8296

#DecisionTree PLot  
rpart.plot(model1,main="Tree",extra=102, under=TRUE,faclen=0)

## Warning: labs do not fit even at cex 0.15, there may be some overplotting

 Above, we looked at the data using a Decision Tree to predit the values for A-E. One figure to note is the low accuracy rate hovering around 65%. Now, we look at a different way to conduct the prediction that involves the use of a random Forest tree

model1<- rpart( classe ~ ., data= training, method = "class")  
  
pred<- predict(model1, testing, type ="class")  
  
confusionMatrix(pred, testing$classe)

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction A B C D E  
## A 1238 139 25 52 35  
## B 45 583 48 59 89  
## C 24 76 682 122 79  
## D 62 72 47 520 57  
## E 26 79 53 51 641  
##   
## Overall Statistics  
##   
## Accuracy : 0.7471   
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## No Information Rate : 0.2845   
## P-Value [Acc > NIR] : < 2.2e-16   
##   
## Kappa : 0.6795   
## Mcnemar's Test P-Value : < 2.2e-16   
##   
## Statistics by Class:  
##   
## Class: A Class: B Class: C Class: D Class: E  
## Sensitivity 0.8875 0.6143 0.7977 0.6468 0.7114  
## Specificity 0.9285 0.9391 0.9257 0.9420 0.9478  
## Pos Pred Value 0.8314 0.7075 0.6938 0.6860 0.7541  
## Neg Pred Value 0.9540 0.9103 0.9559 0.9315 0.9359  
## Prevalence 0.2845 0.1935 0.1743 0.1639 0.1837  
## Detection Rate 0.2524 0.1189 0.1391 0.1060 0.1307  
## Detection Prevalence 0.3036 0.1680 0.2004 0.1546 0.1733  
## Balanced Accuracy 0.9080 0.7767 0.8617 0.7944 0.8296

Conclusion:

Overall, the random Forestis much more accurate at predicting the values. Its accuracy rate is > 99%. So, in my opinion it is much better to use a random forest as it is the most accurate prediction model.