practical machine learning project

Itay Carmel

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The goal

The mission in this project is to train a model on dataset of people exercise to predict the manner in which they did the exercise.which is “classe” variable.

Building the model

First, we downloaded and read the file:

```
url<-"https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv"
destfile<-"C:/Users/ICarmel/Documents/R/pmltraining.csv"
download.file(url,destfile)
mydata<-read.csv("pmltraining.csv")
```

Next, we explore the data:

```
dim(mydata)
```

```
## [1] 19622   160
```

```
names(mydata)
```

```
##   [1] "X"                        "user_name"               
##   [3] "raw_timestamp_part_1"     "raw_timestamp_part_2"    
##   [5] "cvtd_timestamp"           "new_window"              
##   [7] "num_window"               "roll_belt"               
##   [9] "pitch_belt"               "yaw_belt"                
##  [11] "total_accel_belt"         "kurtosis_roll_belt"      
##  [13] "kurtosis_picth_belt"      "kurtosis_yaw_belt"       
##  [15] "skewness_roll_belt"       "skewness_roll_belt.1"    
##  [17] "skewness_yaw_belt"        "max_roll_belt"           
##  [19] "max_picth_belt"           "max_yaw_belt"            
##  [21] "min_roll_belt"            "min_pitch_belt"          
##  [23] "min_yaw_belt"             "amplitude_roll_belt"     
##  [25] "amplitude_pitch_belt"     "amplitude_yaw_belt"      
##  [27] "var_total_accel_belt"     "avg_roll_belt"           
##  [29] "stddev_roll_belt"         "var_roll_belt"           
##  [31] "avg_pitch_belt"           "stddev_pitch_belt"       
##  [33] "var_pitch_belt"           "avg_yaw_belt"            
##  [35] "stddev_yaw_belt"          "var_yaw_belt"            
##  [37] "gyros_belt_x"             "gyros_belt_y"            
##  [39] "gyros_belt_z"             "accel_belt_x"            
##  [41] "accel_belt_y"             "accel_belt_z"            
##  [43] "magnet_belt_x"            "magnet_belt_y"           
##  [45] "magnet_belt_z"            "roll_arm"                
##  [47] "pitch_arm"                "yaw_arm"                 
##  [49] "total_accel_arm"          "var_accel_arm"           
##  [51] "avg_roll_arm"             "stddev_roll_arm"         
##  [53] "var_roll_arm"             "avg_pitch_arm"           
##  [55] "stddev_pitch_arm"         "var_pitch_arm"           
##  [57] "avg_yaw_arm"              "stddev_yaw_arm"          
##  [59] "var_yaw_arm"              "gyros_arm_x"             
##  [61] "gyros_arm_y"              "gyros_arm_z"             
##  [63] "accel_arm_x"              "accel_arm_y"             
##  [65] "accel_arm_z"              "magnet_arm_x"            
##  [67] "magnet_arm_y"             "magnet_arm_z"            
##  [69] "kurtosis_roll_arm"        "kurtosis_picth_arm"      
##  [71] "kurtosis_yaw_arm"         "skewness_roll_arm"       
##  [73] "skewness_pitch_arm"       "skewness_yaw_arm"
##  [75] "max_roll_arm"             "max_picth_arm"
##  [77] "max_yaw_arm"              "min_roll_arm"
##  [79] "min_pitch_arm"            "min_yaw_arm"
##  [81] "amplitude_roll_arm"       "amplitude_pitch_arm"
##  [83] "amplitude_yaw_arm"        "roll_dumbbell"
##  [85] "pitch_dumbbell"           "yaw_dumbbell"
##  [87] "kurtosis_roll_dumbbell"   "kurtosis_picth_dumbbell"
##  [89] "kurtosis_yaw_dumbbell"    "skewness_roll_dumbbell"
##  [91] "skewness_pitch_dumbbell"  "skewness_yaw_dumbbell"
##  [93] "max_roll_dumbbell"        "max_picth_dumbbell"
##  [95] "max_yaw_dumbbell"         "min_roll_dumbbell"
##  [97] "min_pitch_dumbbell"       "min_yaw_dumbbell"
##  [99] "amplitude_roll_dumbbell"  "amplitude_pitch_dumbbell"
## [101] "amplitude_yaw_dumbbell"   "total_accel_dumbbell"
## [103] "var_accel_dumbbell"       "avg_roll_dumbbell"
## [105] "stddev_roll_dumbbell"     "var_roll_dumbbell"
## [107] "avg_pitch_dumbbell"       "stddev_pitch_dumbbell"
## [109] "var_pitch_dumbbell"       "avg_yaw_dumbbell"
## [111] "stddev_yaw_dumbbell"      "var_yaw_dumbbell"
## [113] "gyros_dumbbell_x"         "gyros_dumbbell_y"
## [115] "gyros_dumbbell_z"         "accel_dumbbell_x"
## [117] "accel_dumbbell_y"         "accel_dumbbell_z"
## [119] "magnet_dumbbell_x"        "magnet_dumbbell_y"
## [121] "magnet_dumbbell_z"        "roll_forearm"
## [123] "pitch_forearm"            "yaw_forearm"
## [125] "kurtosis_roll_forearm"    "kurtosis_picth_forearm"
## [127] "kurtosis_yaw_forearm"     "skewness_roll_forearm"
## [129] "skewness_pitch_forearm"   "skewness_yaw_forearm"
## [131] "max_roll_forearm"         "max_picth_forearm"
## [133] "max_yaw_forearm"          "min_roll_forearm"
## [135] "min_pitch_forearm"        "min_yaw_forearm"
## [137] "amplitude_roll_forearm"   "amplitude_pitch_forearm"
## [139] "amplitude_yaw_forearm"    "total_accel_forearm"
## [141] "var_accel_forearm"        "avg_roll_forearm"
## [143] "stddev_roll_forearm"      "var_roll_forearm"
## [145] "avg_pitch_forearm"        "stddev_pitch_forearm"
## [147] "var_pitch_forearm"        "avg_yaw_forearm"
## [149] "stddev_yaw_forearm"       "var_yaw_forearm"
## [151] "gyros_forearm_x"          "gyros_forearm_y"
## [153] "gyros_forearm_z"          "accel_forearm_x"
## [155] "accel_forearm_y"          "accel_forearm_z"
## [157] "magnet_forearm_x"         "magnet_forearm_y"
## [159] "magnet_forearm_z"         "classe"
```

```
str(mydata)
```

```
## 'data.frame':    19622 obs. of  160 variables:
##  $ X                       : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ user_name               : Factor w/ 6 levels "adelmo","carlitos",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ raw_timestamp_part_1    : int  1323084231 1323084231 1323084231 1323084232 1323084232 1323084232 1323084232 132
3084232 1323084232 1323084232 ...
##  $ raw_timestamp_part_2    : int  788290 808298 820366 120339 196328 304277 368296 440390 484323 484434 ...
##  $ cvtd_timestamp          : Factor w/ 20 levels "02/12/2011 13:32",..: 9 9 9 9 9 9 9 9 9 9 ...
##  $ new_window              : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1 ...
##  $ num_window              : int  11 11 11 12 12 12 12 12 12 12 ...
##  $ roll_belt               : num  1.41 1.41 1.42 1.48 1.48 1.45 1.42 1.42 1.43 1.45 ...
##  $ pitch_belt              : num  8.07 8.07 8.07 8.05 8.07 8.06 8.09 8.13 8.16 8.17 ...
##  $ yaw_belt                : num  -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 ...
##  $ total_accel_belt        : int  3 3 3 3 3 3 3 3 3 3 ...
##  $ kurtosis_roll_belt      : Factor w/ 397 levels "","-0.016850",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_picth_belt     : Factor w/ 317 levels "","-0.021887",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_yaw_belt       : Factor w/ 2 levels "","#DIV/0!": 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_roll_belt      : Factor w/ 395 levels "","-0.003095",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_roll_belt.1    : Factor w/ 338 levels "","-0.005928",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_yaw_belt       : Factor w/ 2 levels "","#DIV/0!": 1 1 1 1 1 1 1 1 1 1 ...
##  $ max_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_picth_belt          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_belt            : Factor w/ 68 levels "","-0.1","-0.2",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ min_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_belt          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_belt            : Factor w/ 68 levels "","-0.1","-0.2",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ amplitude_roll_belt     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_pitch_belt    : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_yaw_belt      : Factor w/ 4 levels "","#DIV/0!","0.00",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ var_total_accel_belt    : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_roll_belt        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_pitch_belt          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_pitch_belt       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_pitch_belt          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_yaw_belt         : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ gyros_belt_x            : num  0 0.02 0 0.02 0.02 0.02 0.02 0.02 0.02 0.03 ...
##  $ gyros_belt_y            : num  0 0 0 0 0.02 0 0 0 0 0 ...
##  $ gyros_belt_z            : num  -0.02 -0.02 -0.02 -0.03 -0.02 -0.02 -0.02 -0.02 -0.02 0 ...
##  $ accel_belt_x            : int  -21 -22 -20 -22 -21 -21 -22 -22 -20 -21 ...
##  $ accel_belt_y            : int  4 4 5 3 2 4 3 4 2 4 ...
##  $ accel_belt_z            : int  22 22 23 21 24 21 21 21 24 22 ...
##  $ magnet_belt_x           : int  -3 -7 -2 -6 -6 0 -4 -2 1 -3 ...
##  $ magnet_belt_y           : int  599 608 600 604 600 603 599 603 602 609 ...
##  $ magnet_belt_z           : int  -313 -311 -305 -310 -302 -312 -311 -313 -312 -308 ...
##  $ roll_arm                : num  -128 -128 -128 -128 -128 -128 -128 -128 -128 -128 ...
##  $ pitch_arm               : num  22.5 22.5 22.5 22.1 22.1 22 21.9 21.8 21.7 21.6 ...
##  $ yaw_arm                 : num  -161 -161 -161 -161 -161 -161 -161 -161 -161 -161 ...
##  $ total_accel_arm         : int  34 34 34 34 34 34 34 34 34 34 ...
##  $ var_accel_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_roll_arm         : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_pitch_arm        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_yaw_arm             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_yaw_arm          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_yaw_arm             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ gyros_arm_x             : num  0 0.02 0.02 0.02 0 0.02 0 0.02 0.02 0.02 ...
##  $ gyros_arm_y             : num  0 -0.02 -0.02 -0.03 -0.03 -0.03 -0.03 -0.02 -0.03 -0.03 ...
##  $ gyros_arm_z             : num  -0.02 -0.02 -0.02 0.02 0 0 0 0 -0.02 -0.02 ...
##  $ accel_arm_x             : int  -288 -290 -289 -289 -289 -289 -289 -289 -288 -288 ...
##  $ accel_arm_y             : int  109 110 110 111 111 111 111 111 109 110 ...
##  $ accel_arm_z             : int  -123 -125 -126 -123 -123 -122 -125 -124 -122 -124 ...
##  $ magnet_arm_x            : int  -368 -369 -368 -372 -374 -369 -373 -372 -369 -376 ...
##  $ magnet_arm_y            : int  337 337 344 344 337 342 336 338 341 334 ...
##  $ magnet_arm_z            : int  516 513 513 512 506 513 509 510 518 516 ...
##  $ kurtosis_roll_arm       : Factor w/ 330 levels "","-0.02438",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_picth_arm      : Factor w/ 328 levels "","-0.00484",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_yaw_arm        : Factor w/ 395 levels "","-0.01548",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_roll_arm       : Factor w/ 331 levels "","-0.00051",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_pitch_arm      : Factor w/ 328 levels "","-0.00184",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_yaw_arm        : Factor w/ 395 levels "","-0.00311",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ max_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_picth_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_arm             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_arm             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_roll_arm      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_pitch_arm     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_yaw_arm       : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ roll_dumbbell           : num  13.1 13.1 12.9 13.4 13.4 ...
##  $ pitch_dumbbell          : num  -70.5 -70.6 -70.3 -70.4 -70.4 ...
##  $ yaw_dumbbell            : num  -84.9 -84.7 -85.1 -84.9 -84.9 ...
##  $ kurtosis_roll_dumbbell  : Factor w/ 398 levels "","-0.0035","-0.0073",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_picth_dumbbell : Factor w/ 401 levels "","-0.0163","-0.0233",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ kurtosis_yaw_dumbbell   : Factor w/ 2 levels "","#DIV/0!": 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_roll_dumbbell  : Factor w/ 401 levels "","-0.0082","-0.0096",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_pitch_dumbbell : Factor w/ 402 levels "","-0.0053","-0.0084",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ skewness_yaw_dumbbell   : Factor w/ 2 levels "","#DIV/0!": 1 1 1 1 1 1 1 1 1 1 ...
##  $ max_roll_dumbbell       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_picth_dumbbell      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_dumbbell        : Factor w/ 73 levels "","-0.1","-0.2",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ min_roll_dumbbell       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_dumbbell      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_dumbbell        : Factor w/ 73 levels "","-0.1","-0.2",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ amplitude_roll_dumbbell : num  NA NA NA NA NA NA NA NA NA NA ...
##   [list output truncated]
```

About 67 variables are actually missing, noted as NA, i.e are meaningless for our pourpose.

Therefore it would make sense to omit them from the dataset:

```
mydata<-mydata[ , apply(mydata, 2, function(x) !any(is.na(x)))]
```

We are left with 93 variable and 19622 observations(rows).

We will Split the data based on the “classe” variable so we could train the model on the training portion and than test it on new data.

```
inTrain <- createDataPartition(mydata$classe, p = 3/4)[[1]]
training <- mydata[ inTrain,]
testing <- mydata[-inTrain,]
```

Now we should estimate the importance of each variable and its potential contribution to our model.

To do this, we will use Boruta package. Boruta is a feature ranking and selection algorithm based on random forests algorithm.

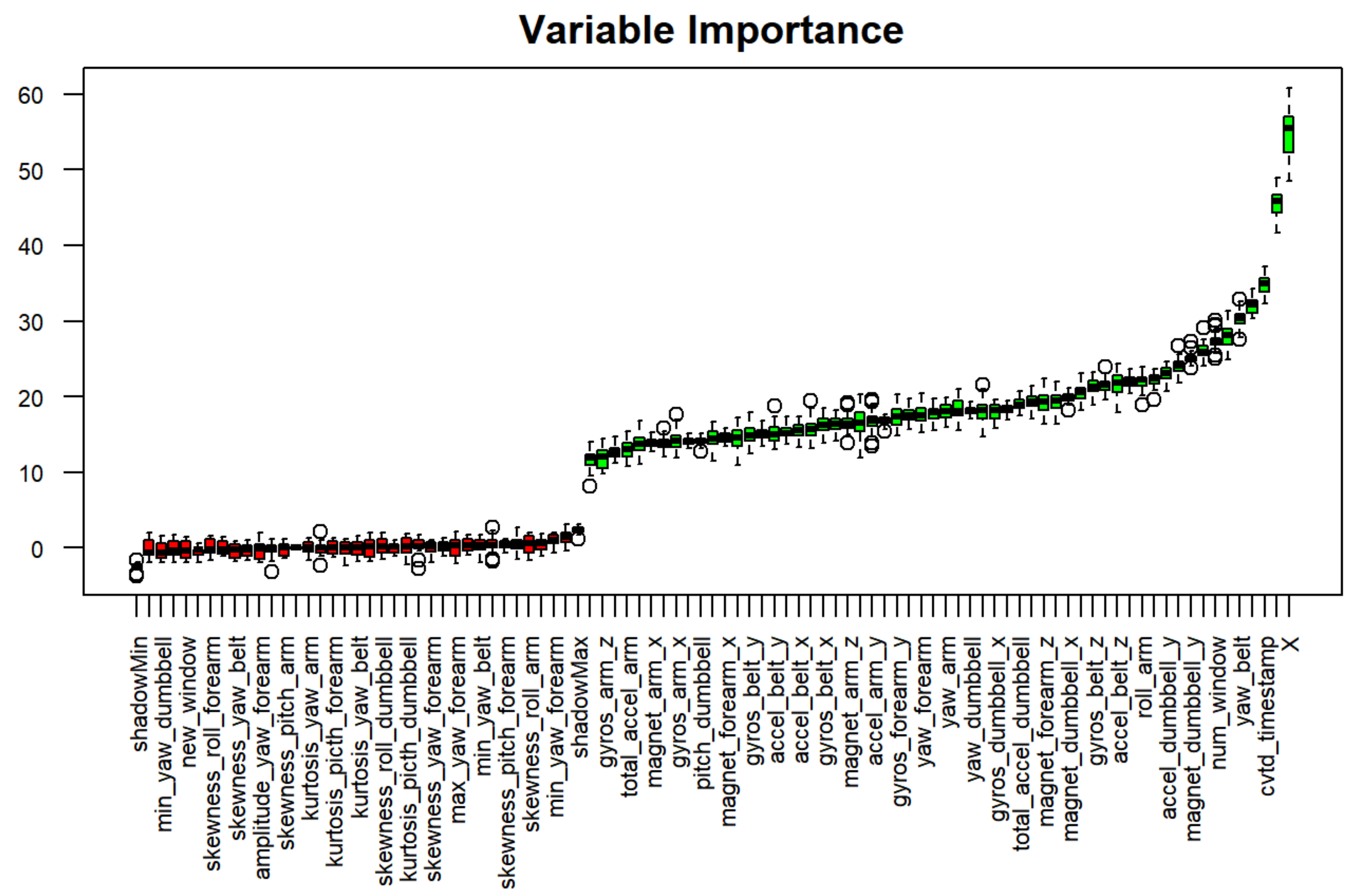
```
## Warning: package 'Boruta' was built under R version 3.6.2
```

```
## Loading required package: ranger
```

```
## Warning: package 'ranger' was built under R version 3.6.2
```

```
## Computing permutation importance.. Progress: 38%. Estimated remaining time: 51 seconds.
## Computing permutation importance.. Progress: 49%. Estimated remaining time: 32 seconds.
## Computing permutation importance.. Progress: 98%. Estimated remaining time: 1 seconds.
## Computing permutation importance.. Progress: 67%. Estimated remaining time: 15 seconds.
## Computing permutation importance.. Progress: 65%. Estimated remaining time: 16 seconds.
## Computing permutation importance.. Progress: 88%. Estimated remaining time: 4 seconds.
## Computing permutation importance.. Progress: 85%. Estimated remaining time: 5 seconds.
## Computing permutation importance.. Progress: 84%. Estimated remaining time: 5 seconds.
## Computing permutation importance.. Progress: 93%. Estimated remaining time: 2 seconds.
## Computing permutation importance.. Progress: 96%. Estimated remaining time: 1 seconds.
## Computing permutation importance.. Progress: 93%. Estimated remaining time: 2 seconds.
## Computing permutation importance.. Progress: 96%. Estimated remaining time: 1 seconds.
## Computing permutation importance.. Progress: 99%. Estimated remaining time: 0 seconds.
## Computing permutation importance.. Progress: 95%. Estimated remaining time: 1 seconds.
## Computing permutation importance.. Progress: 98%. Estimated remaining time: 0 seconds.
```

```
par(mar = c(10, 2, 2,2))
plot(boruta_output, cex.axis=.7, las=2, xlab="", main="Variable Importance")
```



```
roughFixMod <- TentativeRoughFix(boruta_output)
```

```
## Warning in TentativeRoughFix(boruta_output): There are no Tentative
## attributes! Returning original object.
```

```
imps <- attStats(roughFixMod)
imps2 = imps[imps$decision != 'Rejected', c('meanImp', 'decision')]
head(imps2[order(-imps2$meanImp), ],6)
```

```
##                         meanImp  decision
## X                      54.93618 Confirmed
## raw_timestamp_part_1 45.72889 Confirmed
## cvtd_timestamp       34.90563 Confirmed
## roll_belt            32.04918 Confirmed
## yaw_belt             30.30517 Confirmed
## pitch_belt           28.07317 Confirmed
```

The graph as well as the list we got tells us the importance rate of the variables.

We can see that the top 6 important variables are:

1. raw_timestamp_part_1
2. cvtd_timestamp
3. roll_belt
4. yaw_belt
5. pitch_belt
6. num_window

However, since “cvtd_timestamp” is actually the date and time the activity was measured we will exclude it from the variables list.

Now we will train a random forest model. We based on random forest algorithm for two reason:

1. It provides higher accuracy.
2. It has the power to handle a large data set with higher dimensionality.

In addintion, in random forests, there is no need for cross-validation or a separate test set to get an unbiased estimate of the test set error. It is estimated internally, during the run, as follows:

Each tree is constructed using a different bootstrap sample from the original data. About one-third of the cases are left out of the bootstrap sample and not used in the construction of the kth tree (a snippet from Breiman’s official documentation (https://www.stat.berkeley.edu/~breiman/RandomForests/cc_home.htm#ooberr))

```
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:ranger':
##
##     importance
```

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

```
model<-randomForest(classe~raw_timestamp_part_1+roll_belt+yaw_belt+pitch_belt+num_window,data=training)
print(model)
```

```
##
## Call:
##  randomForest(formula = classe ~ raw_timestamp_part_1 + roll_belt +      yaw_belt + pitch_belt + num_window, data
= training)
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 2
##
##         OOB estimate of  error rate: 0.04%
## Confusion matrix:
##      A    B    C    D    E  class.error
## A 4185    0    0    0    0 0.0000000000
## B    1 2847    0    0    0 0.0003511236
## C    0    1 2565    1    0 0.0007791196
## D    0    0    0 2411    1 0.0004145937
## E    0    1    0    1 2704 0.0007390983
```

We can see The OOB estimate of error rate: 0.03%, which is relatively low. Hence, we will run confusion matrix to compare the model result with actual out of sample error which is our test portion of the sample

```
pred<-predict(model,testing)
confusionMatrix(pred,testing$classe)
```

```
## Confusion Matrix and Statistics
## 
##           Reference
## Prediction    A    B    C    D    E
##          A 1395    0    0    0    0
##          B    0  949    0    0    0
##          C    0    0  855    0    0
##          D    0    0    0  804    0
##          E    0    0    0    0  901
## 
## Overall Statistics
##                                      
##                Accuracy : 1          
##                  95% CI : (0.9992, 1)
##     No Information Rate : 0.2845     
##     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             0.2845   0.1935   0.1743   0.1639   0.1837
## Detection Rate         0.2845   0.1935   0.1743   0.1639   0.1837
## Detection Prevalence   0.2845   0.1935   0.1743   0.1639   0.1837
## Balanced Accuracy      1.0000   1.0000   1.0000   1.0000   1.0000
```

We can see that the accuracy of our model is 0.9998 which is pretty good.

Now we will run the model on the test data:

```
url<-"https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv"
destfile<-"C:/Users/ICarmel/Documents/R/pmltest.csv"
download.file(url,destfile)
testdata<-read.csv("pmltest.csv")
predtest<-predict(model,testdata)
print(predtest)
```

```
##  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
##  B  A  B  A  A  E  D  B  A  A  B  C  B  A  E  E  A  B  B  B
## Levels: A B C D E
```