Peer-graded Assignment: Prediction Assignment Writeup

R. Camara

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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. More information is available from the website here (see the section on the Weight Lifting Exercise Dataset).

Data

The training data for this project are available here

The test data are available here

Data rocessing

Packages

```
knitr::opts_chunk$set(echo = TRUE)
options(width=120)
library(caret)
library(pander)
library(randomForest)
library(corrplot)
```

Loading and cacheing the data

```
training.data <- read.csv("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv")
testing.data <- read.csv("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv")
```

If we look in Appendix A we can see that there is a large number of NA values so we will clean the dataset to begin with.

Partitioning with the training set

```
in.train  <- createDataPartition(training.data$classe, p=0.7, list=FALSE)
training.data.cl <- training.data[in.train, ]
testing.data.cl  <- training.data[-in.train, ]
```

Removing the near-zero variance predictors

```
nzv <- nearZeroVar(training.data.cl, saveMetrics = T)
training.data.cl <- training.data.cl[, !nzv$nzv]
testing.data.cl <- testing.data.cl[, !nzv$nzv]
```

Getting rid of NA columns

```
nas <- (colSums(is.na(training.data.cl)) == 0)
training.data.cl <- training.data.cl[, nas]
testing.data.cl <- testing.data.cl[, nas]
```

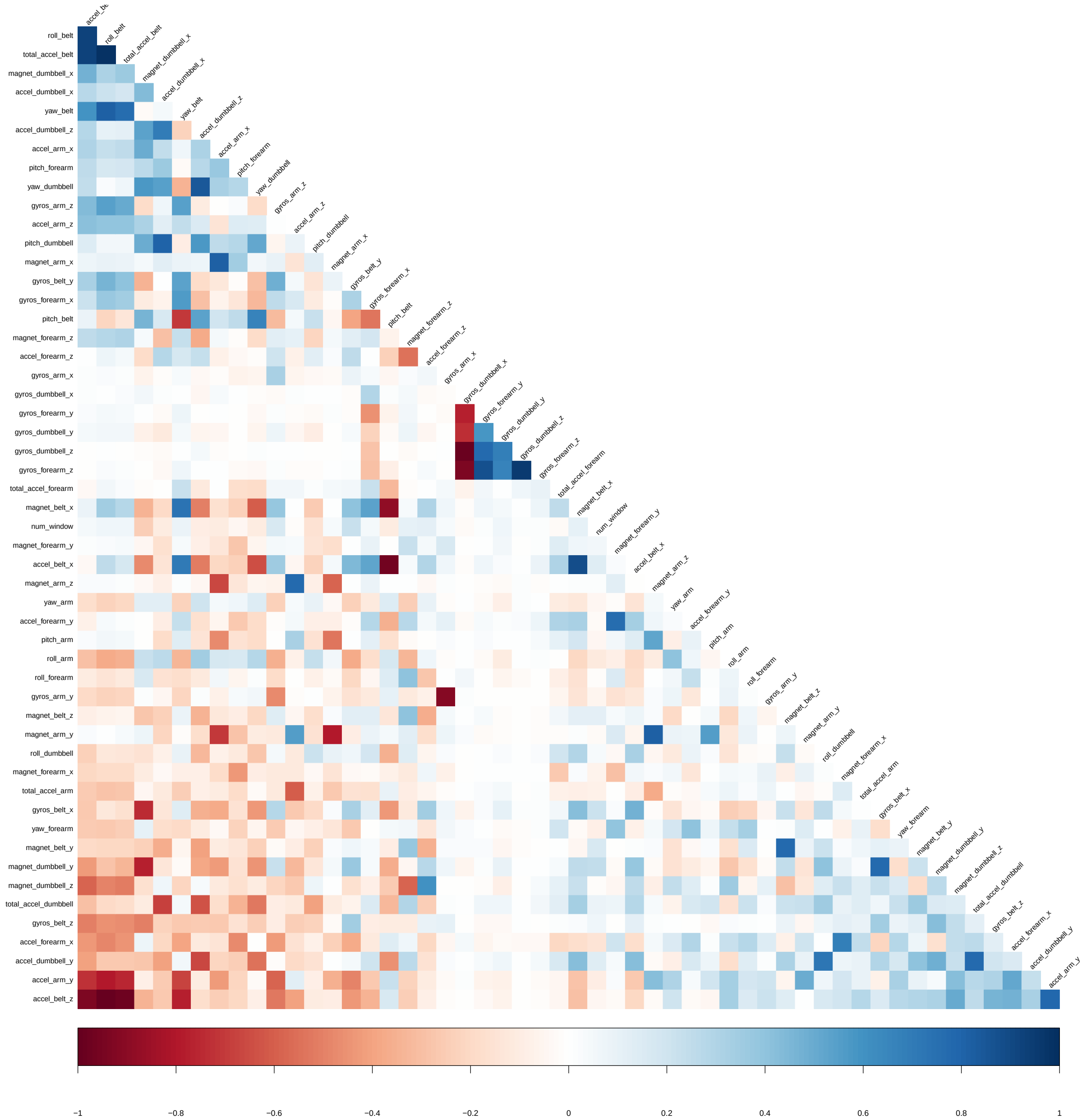
Removing the user & time data

```
training.data.cl <- training.data.cl[ , -c(1:5)]
testing.data.cl <- testing.data.cl[ , -c(1:5)]
```

Modeling: prediction model building

Verifying correlation analysis

```
cor.matrix <- cor(training.data.cl[, -54])
corrplot(cor.matrix, order="FPC", tl.cex=0.75, method="color", tl.col="black", tl.srt = 45, type="lower
```



Model selection

The highly correlated variables are shown in dark colours in the graph above. A PCA analysis won't be performed due to the rather sparse nature of the correlations.

Both a GBM and RF model will be trained and the the results compared.

Training a generalised boosted model

```
set.seed(56346)

GBM.ctl <-
```

```r
  trainControl(method = "repeatedcv",
               number = 5,
               repeats = 1)

GBM.fit  <-
  train(
    classe ~ .,
    data = training.data.cl,
    method = "gbm",
    trControl = GBM.ctl,
    verbose = FALSE
  )

GBM.fit$finalModel
```

```
## A gradient boosted model with multinomial loss function.
## 150 iterations were performed.
## There were 53 predictors of which 41 had non-zero influence.
```

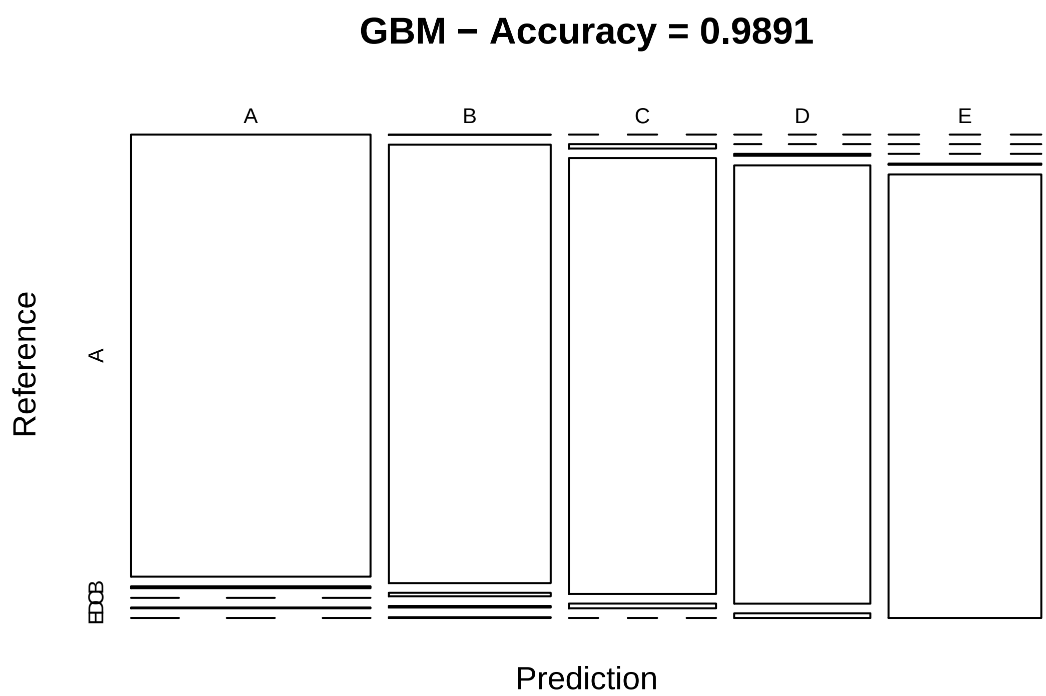
Verifying the GBM Model

```r
GBM.predict <- predict(GBM.fit, newdata = testing.data.cl)
GBM.cfx <- confusionMatrix(GBM.predict, testing.data.cl$classe)
GBM.cfx
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1673    7    0    3    0
##          B    1 1122    9    4    2
##          C    0   10 1013   11    0
##          D    0    0    4  943   10
##          E    0    0    0    3 1070
##
## Overall Statistics
##
##                Accuracy : 0.9891
##                  95% CI : (0.9861, 0.9916)
##     No Information Rate : 0.2845
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9862
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            0.9994   0.9851   0.9873   0.9782   0.9889
## Specificity            0.9976   0.9966   0.9957   0.9972   0.9994
## Pos Pred Value         0.9941   0.9859   0.9797   0.9854   0.9972
## Neg Pred Value         0.9998   0.9964   0.9973   0.9957   0.9975
## Prevalence             0.2845   0.1935   0.1743   0.1638   0.1839
```

```
## Detection Rate          0.2843   0.1907   0.1721   0.1602   0.1818
## Detection Prevalence    0.2860   0.1934   0.1757   0.1626   0.1823
## Balanced Accuracy       0.9985   0.9909   0.9915   0.9877   0.9941
```

```
plot(GBM.cfx$table,
     col = GBM.cfx$byClass,
     main = paste("GBM - Accuracy =", round(GBM.cfx$overall['Accuracy'], 4)))
```



Training a random forest model

```
set.seed(56346)
random.forest.ctl <-
  trainControl(method = "cv",
               number = 3,
               verboseIter = FALSE)

random.forest.fit <-
  train(classe ~ .,
        data = training.data.cl,
        method = "rf",
        trControl = random.forest.ctl)

random.forest.fit$finalModel
```

```
##
```

```
## Call:
##  randomForest(x = x, y = y, mtry = param$mtry)
##                Type of random forest: classification
##                      Number of trees: 500
## No. of variables tried at each split: 27
##
##         OOB estimate of  error rate: 0.22%
## Confusion matrix:
##      A    B    C    D    E  class.error
## A 3905    0    0    0    1 0.0002560164
## B    7 2648    3    0    0 0.0037622272
## C    0    3 2392    1    0 0.0016694491
## D    0    0    9 2243    0 0.0039964476
## E    0    1    0    5 2519 0.0023762376
```

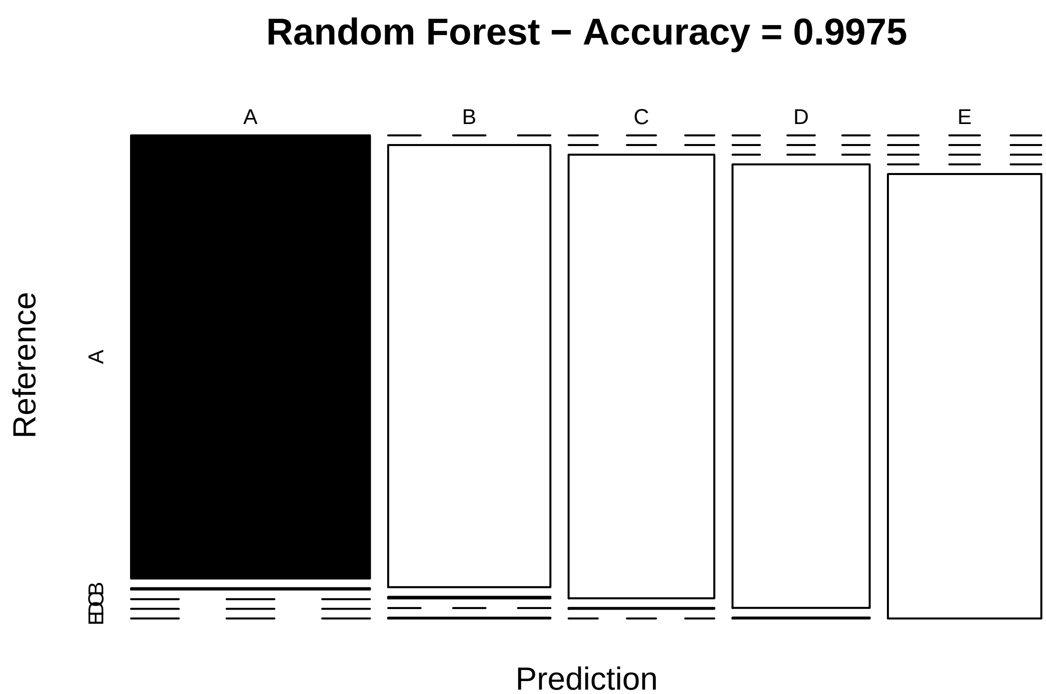
Verifying the random forest model

```
random.forest.predict <-
  predict(random.forest.fit, newdata = testing.data.cl)
random.forest.cfx <-
  confusionMatrix(random.forest.predict, testing.data.cl$classe)
random.forest.cfx
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1674    5    0    0    0
##          B    0 1134    4    0    2
##          C    0    0 1022    2    0
##          D    0    0    0  962    2
##          E    0    0    0    0 1078
##
## Overall Statistics
##
##                Accuracy : 0.9975
##                  95% CI : (0.9958, 0.9986)
##     No Information Rate : 0.2845
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9968
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            1.0000   0.9956   0.9961   0.9979   0.9963
## Specificity            0.9988   0.9987   0.9996   0.9996   1.0000
## Pos Pred Value         0.9970   0.9947   0.9980   0.9979   1.0000
## Neg Pred Value         1.0000   0.9989   0.9992   0.9996   0.9992
## Prevalence             0.2845   0.1935   0.1743   0.1638   0.1839
## Detection Rate         0.2845   0.1927   0.1737   0.1635   0.1832
## Detection Prevalence   0.2853   0.1937   0.1740   0.1638   0.1832
```

```
## Balanced Accuracy      0.9994   0.9972   0.9978   0.9988   0.9982
```

```
plot(
  random.forest.cfx$table,
  col = random.forest.cfx$byClass,
  main = paste(
    "Random Forest - Accuracy =",
    round(random.forest.cfx$overall['Accuracy'], 4)
  )
)
```



Conclusion & running prediction against the teststing data

We will use the the random forest model as it has the highest accuracy of 0.9973 and OOB estimate of error rate 0.23%

```
predict.test <- predict(random.forest.fit, newdata = testing.data)
predict.test
```

```
##  [1] 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
```

Appendix A__testing dataset

Pre-cleaning the data

```
str(training.data)
```

```
## '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 1
##  $ raw_timestamp_part_2    : int  788290 808298 820366 120339 196328 304277 368296 440390 484323 4844
##  $ 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]
```

Post-cleaning the data

```
str(training.data.cl)
```

```
## 'data.frame':    13737 obs. of  54 variables:
##  $ num_window          : int  11 11 12 12 12 12 12 12 12 12 ...
##  $ roll_belt           : num  1.41 1.41 1.48 1.48 1.45 1.42 1.43 1.45 1.45 1.42 ...
##  $ pitch_belt          : num  8.07 8.07 8.05 8.07 8.06 8.13 8.16 8.17 8.18 8.2 ...
##  $ 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 ...
##  $ gyros_belt_x        : num  0 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03 0.02 ...
##  $ gyros_belt_y        : num  0 0 0 0.02 0 0 0 0 0 0 ...
##  $ gyros_belt_z        : num  -0.02 -0.02 -0.03 -0.02 -0.02 -0.02 -0.02 0 -0.02 0 ...
##  $ accel_belt_x        : int  -21 -22 -22 -21 -21 -22 -20 -21 -21 -22 ...
##  $ accel_belt_y        : int  4 4 3 2 4 4 2 4 2 4 ...
##  $ accel_belt_z        : int  22 22 21 24 21 21 24 22 23 21 ...
##  $ magnet_belt_x       : int  -3 -7 -6 -6 0 -2 1 -3 -5 -3 ...
##  $ magnet_belt_y       : int  599 608 604 600 603 603 602 609 596 606 ...
##  $ magnet_belt_z       : int  -313 -311 -310 -302 -312 -313 -312 -308 -317 -309 ...
##  $ roll_arm            : num  -128 -128 -128 -128 -128 -128 -128 -128 -128 -128 ...
##  $ pitch_arm           : num  22.5 22.5 22.1 22.1 22 21.8 21.7 21.6 21.5 21.4 ...
##  $ 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 ...
##  $ gyros_arm_x         : num  0 0.02 0.02 0 0.02 0.02 0.02 0.02 0.02 0.02 ...
##  $ gyros_arm_y         : num  0 -0.02 -0.03 -0.03 -0.03 -0.02 -0.03 -0.03 -0.03 -0.02 ...
##  $ gyros_arm_z         : num  -0.02 -0.02 0.02 0 0 0 -0.02 -0.02 0 -0.02 ...
##  $ accel_arm_x         : int  -288 -290 -289 -289 -289 -289 -288 -288 -290 -287 ...
##  $ accel_arm_y         : int  109 110 111 111 111 111 109 110 110 111 ...
##  $ accel_arm_z         : int  -123 -125 -123 -123 -122 -124 -122 -124 -123 -124 ...
##  $ magnet_arm_x        : int  -368 -369 -372 -374 -369 -372 -369 -376 -366 -372 ...
##  $ magnet_arm_y        : int  337 337 344 337 342 338 341 334 339 338 ...
##  $ magnet_arm_z        : int  516 513 512 506 513 510 518 516 509 509 ...
##  $ roll_dumbbell       : num  13.1 13.1 13.4 13.4 13.4 ...
##  $ pitch_dumbbell      : num  -70.5 -70.6 -70.4 -70.4 -70.8 ...
##  $ yaw_dumbbell        : num  -84.9 -84.7 -84.9 -84.9 -84.5 ...
##  $ total_accel_dumbbell: int  37 37 37 37 37 37 37 37 37 37 ...
##  $ gyros_dumbbell_x    : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ gyros_dumbbell_y    : num  -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 ...
##  $ gyros_dumbbell_z    : num  0 0 -0.02 0 0 0 0 0 0 -0.02 ...
##  $ accel_dumbbell_x    : int  -234 -233 -232 -233 -234 -234 -232 -235 -233 -234 ...
##  $ accel_dumbbell_y    : int  47 47 48 48 48 46 47 48 47 48 ...
##  $ accel_dumbbell_z    : int  -271 -269 -269 -270 -269 -272 -269 -270 -269 -269 ...
##  $ magnet_dumbbell_x   : int  -559 -555 -552 -554 -558 -555 -549 -558 -564 -552 ...
##  $ magnet_dumbbell_y   : int  293 296 303 292 294 300 292 291 299 302 ...
##  $ magnet_dumbbell_z   : num  -65 -64 -60 -68 -66 -74 -65 -69 -64 -69 ...
##  $ roll_forearm        : num  28.4 28.3 28.1 28 27.9 27.8 27.7 27.7 27.6 27.2 ...
##  $ pitch_forearm       : num  -63.9 -63.9 -63.9 -63.9 -63.9 -63.8 -63.8 -63.8 -63.8 -63.9 ...
##  $ yaw_forearm         : num  -153 -153 -152 -152 -152 -152 -152 -152 -152 -151 ...
##  $ total_accel_forearm : int  36 36 36 36 36 36 36 36 36 36 ...
##  $ gyros_forearm_x     : num  0.03 0.02 0.02 0.02 0.02 0.02 0.03 0.02 0.02 0 ...
##  $ gyros_forearm_y     : num  0 0 -0.02 0 -0.02 -0.02 0 0 -0.02 0 ...
##  $ gyros_forearm_z     : num  -0.02 -0.02 0 -0.02 -0.03 0 -0.02 -0.02 -0.02 -0.03 ...
##  $ accel_forearm_x     : int  192 192 189 189 193 193 193 190 193 193 ...
##  $ accel_forearm_y     : int  203 203 206 206 203 205 204 205 205 205 ...
```

```
##  $ accel_forearm_z     : int  -215 -216 -214 -214 -215 -213 -214 -215 -214 -215 ...
##  $ magnet_forearm_x    : int  -17 -18 -16 -17 -9 -9 -16 -22 -17 -15 ...
##  $ magnet_forearm_y    : num  654 661 658 655 660 660 653 656 657 655 ...
##  $ magnet_forearm_z    : num  476 473 469 473 478 474 476 473 465 472 ...
##  $ classe              : Factor w/ 5 levels "A","B","C","D",..: 1 1 1 1 1 1 1 1 1 1 ...
```

Appendix B__required packages

Package	Description
caret	caret package
pander	pander package
randomForest	randomForest
corrplot	corrplot

Appendix C__session info package versions

```r
sessionInfo()
```

```
## R version 3.4.2 (2017-09-28)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 16299)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=English_United Kingdom.1252  LC_CTYPE=English_United Kingdom.1252
## [3] LC_MONETARY=English_United Kingdom.1252 LC_NUMERIC=C
## [5] LC_TIME=English_United Kingdom.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] corrplot_0.84       randomForest_4.6-12 pander_0.6.1        caret_6.0-78        ggplot2_2.2.1
## [6] lattice_0.20-35
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.13       lubridate_1.7.1    tidyr_0.7.2        class_7.3-14       assertthat_0.2.0
##  [7] digest_0.6.12      ipred_0.9-6        psych_1.7.8        foreach_1.4.3      R6_2.2.2
## [13] backports_1.1.1    stats4_3.4.2       evaluate_0.10.1    rlang_0.1.2        lazyeval_0.2.0
## [19] rpart_4.1-11       Matrix_1.2-11      rmarkdown_1.6      splines_3.4.2      CVST_0.2-1
## [25] gower_0.1.2        stringr_1.2.0      foreign_0.8-69     munsell_0.4.3      broom_0.4.3
## [31] pkgconfig_2.0.1    mnormt_1.5-5       dimRed_0.1.0       htmltools_0.3.6    nnet_7.3-12
## [37] tibble_1.3.4       prodlim_1.6.1      DRR_0.0.2          codetools_0.2-15   RcppRoll_0.2.2
## [43] withr_2.0.0        MASS_7.3-47        recipes_0.1.1      ModelMetrics_1.1.0 grid_3.4.2
## [49] gtable_0.2.0       magrittr_1.5       scales_0.5.0       stringi_1.1.5      reshape2_1.4.2
## [55] timeDate_3012.100  robustbase_0.92-8  lava_1.5.1         iterators_1.0.8    tools_3.4.2
## [61] DEoptimR_1.0-8     purrr_0.2.4        sfsmisc_1.1-1      parallel_3.4.2     survival_2.41-3
## [67] colorspace_1.3-2   knitr_1.17         bindr_0.1
```

References

The data for this project come from this source: http://web.archive.org/web/20161224072740/http:/groupware.les.inf.puc-rio.br/har. If you use the document you create for this class for any purpose please cite them as they have been very generous in allowing their data to be used for this kind of assignment.