An accessment : How do you know you exercise correctly ?

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: http://groupware.les.inf.puc-rio.br/har (see the section on the Weight Lifting Exercise Dataset).

Dataset

The training data for this project are available here:

https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv

The test data are available here:

https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv

The data for this project come from this source: http://groupware.les.inf.puc-rio.br/har.

Download both training dataset :-

```
set.seed(11111)
library(caret)
```

```
## Warning: package 'caret' was built under R version 3.2.2
```

```
## Loading required package: lattice
## Loading required package: ggplot2
```

```
## Warning: package 'ggplot2' was built under R version 3.2.2
```

```
library(rpart)
library(rpart.plot)
```

```
## Warning: package 'rpart.plot' was built under R version 3.2.2
```

```
library(RColorBrewer)
library(rattle)
```

```
## Warning: package 'rattle' was built under R version 3.2.2
```

```
## Loading required package: RGtk2
```

```
## Warning: package 'RGtk2' was built under R version 3.2.2
```

```
## Rattle: A free graphical interface for data mining with R.
## Version 3.5.0 Copyright (c) 2006-2015 Togaware Pty Ltd.
## Type 'rattle()' to shake, rattle, and roll your data.
```

```
library(randomForest)
```

```
## Warning: package 'randomForest' was built under R version 3.2.2
```

```
## randomForest 4.6-10
## Type rfNews() to see new features/changes/bug fixes.
```

```
curdir <-getwd()
file.url<-'http://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv'
download.file(file.url,destfile=paste(curdir,'/pml-training.csv',sep=""))

curdir <-getwd()
file.url<-'http://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv'
download.file(file.url,destfile=paste(curdir,'/pml-testing.csv',sep=""))
```

Load both dataset :-

```
train <- read.csv(paste(curdir,'/pml-training.csv',sep=""),na.strings=c("NA","#DIV/0!",""))
test <-read.csv(paste(curdir,'/pml-testing.csv',sep=""),na.strings=c("NA","#DIV/0!",""))
```

Cheking the dimension of training and test dataset :-

```
dim(train)
```

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

```
dim(test)
```

```
## [1]  20 160
```

Checking the columns which have all missing values

```
train<-train[,colSums(is.na(train)) == 0]
test <-test[,colSums(is.na(test)) == 0]
```

We remove 6 of the variables which is irrelevant like :-

a) user_name

b) raw_timestamp_part_1

c) raw_timestamp_part_2

d) cvtd_timestamp

e) new_window

f) num_window

which resides on the column 1-7.

```
train <-train[,-c(1:7)]
test <-test[,-c(1:7)]
```

Check again the dimension

```
dim(train)
```

```
## [1] 19622    53
```

```
dim(test)
```

```
## [1] 20 53
```

Now we obtain the several rows to preview

```
head(train)
```

```
##   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(test)
```

```
##   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
```

In order to run cross-validation , the training dataset need to partition into 2 sets . We set the 1st partition for training dataset to 75% and test dataset to 25%. Training dataset contains 53 variables with 19622 obs and test dataset contains 53 variables with 20 obs.

This will do the randomize sub-sampling without replacement

```
PartTrain <- createDataPartition(y=train$classe, p=0.75, list=FALSE)
train_part <- train[PartTrain, ];
test_part <- train[-PartTrain, ]
dim(train_part)
```

```
## [1] 14718    53
```

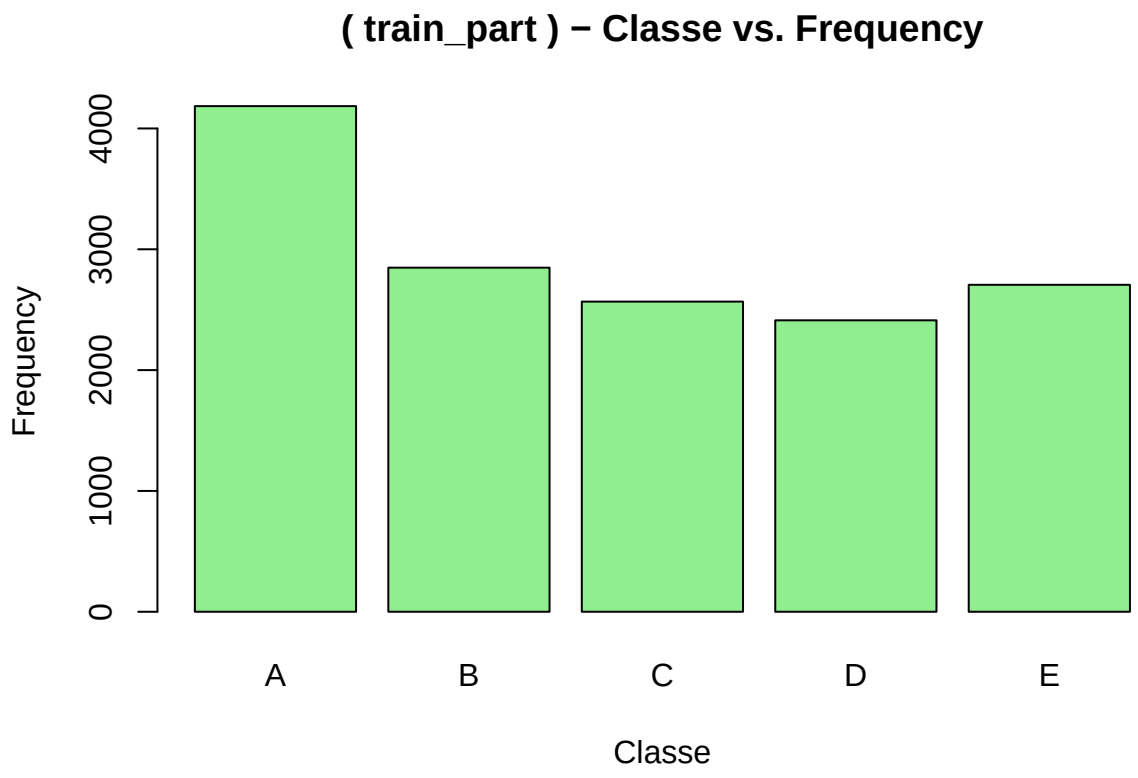
```
dim(test_part)
```

```
## [1] 4904   53
```

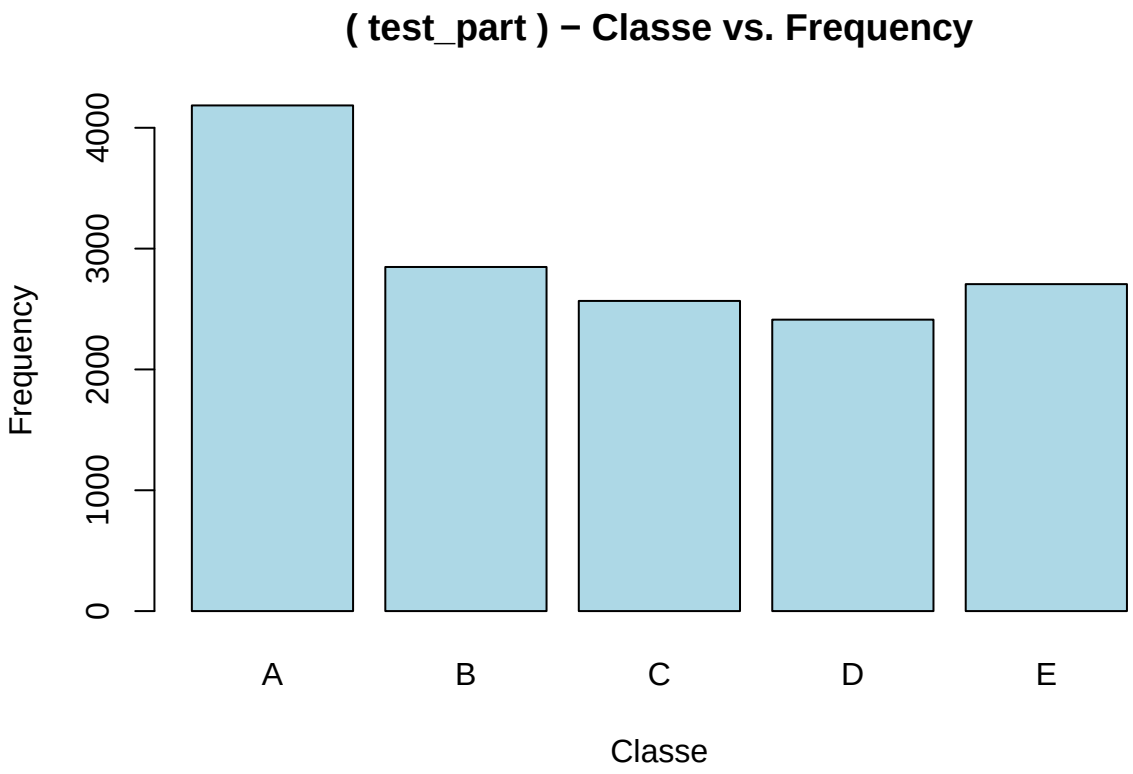
Visualization

We try to plot into the histogram to see the trending frequency of each sub-training & test dataset by comparing with each other. The variable classe contains 5 levels which is A,B,C,D & E

```
plot(train_part$classe, col="lightgreen",
main="( train_part ) - Classe vs. Frequency",
xlab="Classe", ylab="Frequency")
```




```
plot(train_part$classe, col="lightblue",
main="( test_part ) - Classe vs. Frequency",
xlab="Classe", ylab="Frequency")
```



Reference

Velloso, E.; Bulling, A.; Gellersen, H.; Ugulino, W.; Fuks, H. Qualitative Activity Recognition of Weight Lifting Exercises. Proceedings of 4th International Conference in Cooperation with SIGCHI (Augmented Human '13) . Stuttgart, Germany: ACM SIGCHI, 2013. Read more: http://groupware.les.inf.puc-rio.br/har#ixzz3lj0hACeI