

# Prediction Project - Human Activity Recognition

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## Introduction

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 dumbbell 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).

## Data Source

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>. 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.

```
setwd("D:/Data Science/8-Practical Machine Learning/Week4/Project")
if(!dir.exists("./data")){dir.create("./data")}
if(!file.exists("./data/pml-training.csv")){
  download.file("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv", "./data/pml-training.csv")
}
if(!file.exists("./data/pml-testing.csv")){
  download.file("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv", "./data/pml-testing.csv")
}

training_data<-read.csv("./data/pml-training.csv")
testing_data<-read.csv("./data/pml-testing.csv")

dim(training_data)

## [1] 19622 160

dim(testing_data)

## [1] 20 160
```

First set all the data with NULL values to NA and then remove all columns containing NA's and last remove some columns that are not related to dependant variables

```
training_data[training_data==""]<-"NA"
testing_data[testing_data==""]<-"NA"
```

```

training_data<-training_data[,colSums(is.na(training_data))==0]
testing_data<-testing_data[,colSums(is.na(testing_data))==0]

col_del<-c('X','user_name','raw_timestamp_part_1','raw_timestamp_part_2',
           'cvtd_timestamp','new_window','num_window')
training_data<-training_data[,-which(names(training_data) %in% col_del)]
testing_data<-testing_data[,-which(names(testing_data) %in% col_del)]

dim(training_data)

```

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

```
dim(testing_data)
```

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

And last split training\_data into a 60% training and 40% testing data set used to make the cross validation.

```

set.seed(9910)
inTrain<-createDataPartition(training_data$classe,p=0.6,list=FALSE)
dt_training<-training_data[inTrain,]
dt_testing<-training_data[-inTrain,]

dim(dt_training)

```

```
## [1] 11776    53
```

```
dim(dt_testing)
```

```
## [1] 7846    53
```

## Prediction Algorithms

Now we are trying to predict the model

### Random Forest (rf)

```

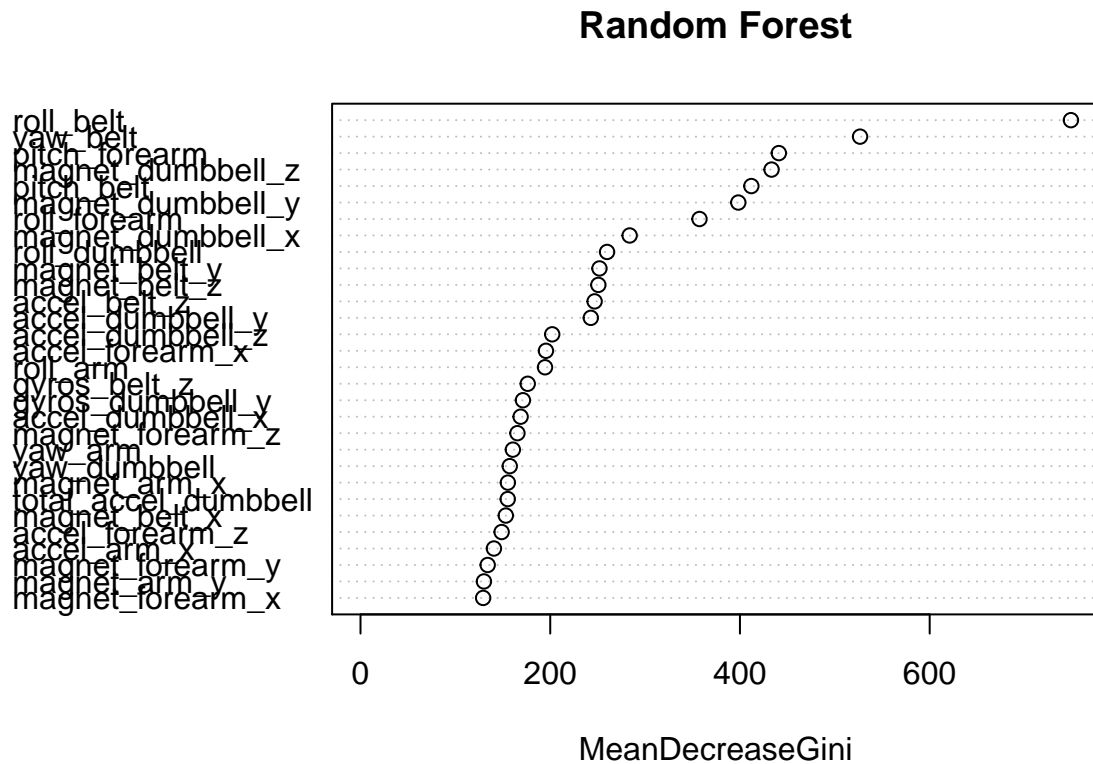
mod_rf<-randomForest(classe~.,data=dt_training,ntree=500)
print(mod_rf)

##
## Call:
## randomForest(formula = classe ~ ., data = dt_training, ntree = 500)
##              Type of random forest: classification
##              Number of trees: 500
## No. of variables tried at each split: 7
##
##              OOB estimate of  error rate: 0.62%
## Confusion matrix:
##              A      B      C      D      E class.error
## A 3344      3      1      0      0 0.001194743
## B   17 2260      2      0      0 0.008336990
## C      0   14 2038      2      0 0.007789679
## D      0      0   23 1905      2 0.012953368

```

```
## E    0    0    3    6 2156 0.004157044
```

```
varImpPlot(mod_rf,main ="Random Forest")
```



```
pred_rf<-predict(mod_rf,newdata=dt_testing)
confusionMatrix(pred_rf,dt_testing$classe)
```

```
## Confusion Matrix and Statistics
```

```
##
```

```
##           Reference
```

```
## Prediction    A    B    C    D    E
```

```
##           A 2227    7    0    0    0
```

```
##           B   2 1502    1    0    0
```

```
##           C    3    9 1365   20    0
```

```
##           D    0    0    2 1262    4
```

```
##           E    0    0    0    4 1438
```

```
##
```

```
## Overall Statistics
```

```
##
```

```
##           Accuracy : 0.9934
```

```
##           95% CI : (0.9913, 0.995)
```

```
##           No Information Rate : 0.2845
```

```
##           P-Value [Acc > NIR] : < 2.2e-16
```

```
##
```

```
##           Kappa : 0.9916
```

```
##           McNemar's Test P-Value : NA
```

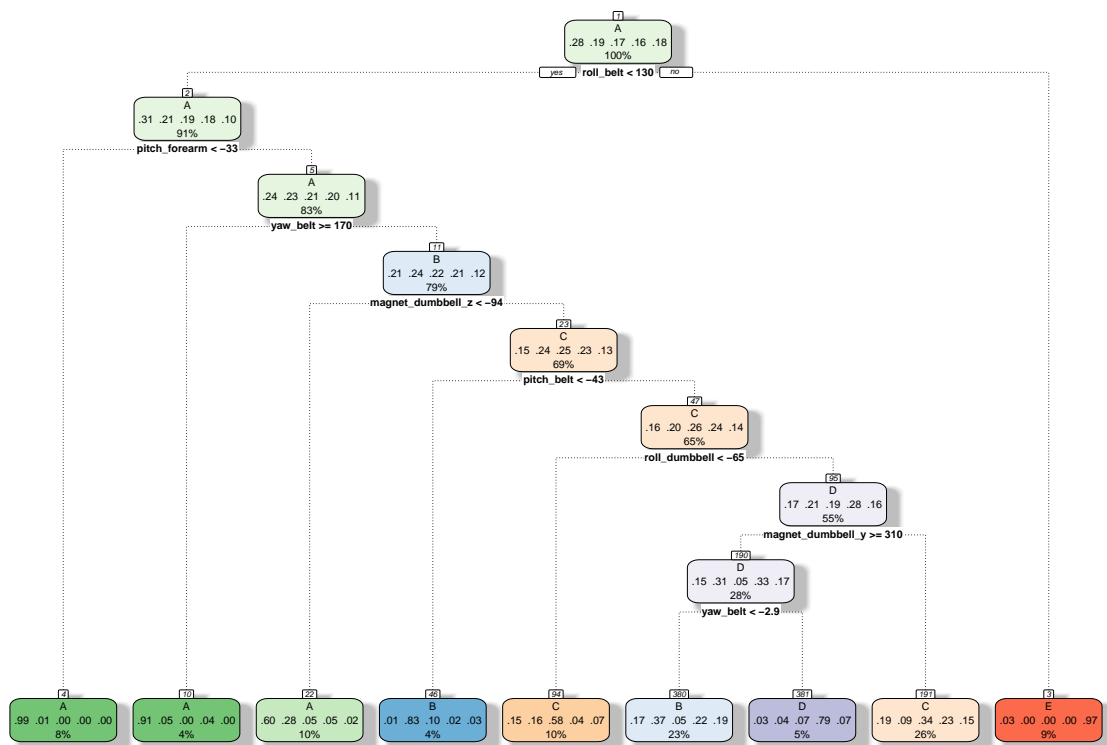
```
##
```

```
## Statistics by Class:
##
##               Class: A Class: B Class: C Class: D Class: E
## Sensitivity      0.9978   0.9895   0.9978   0.9813   0.9972
## Specificity      0.9988   0.9995   0.9951   0.9991   0.9994
## Pos Pred Value   0.9969   0.9980   0.9771   0.9953   0.9972
## Neg Pred Value   0.9991   0.9975   0.9995   0.9964   0.9994
## Prevalence       0.2845   0.1935   0.1744   0.1639   0.1838
## Detection Rate   0.2838   0.1914   0.1740   0.1608   0.1833
## Detection Prevalence 0.2847 0.1918 0.1781 0.1616 0.1838
## Balanced Accuracy 0.9983   0.9945   0.9964   0.9902   0.9983
```

## CART (rpart)

```
mod_rpt<-train(classe~.,data=dt_training,method="rpart")
print(mod_rpt)

## CART
##
## 11776 samples
##    52 predictor
##    5 classes: 'A', 'B', 'C', 'D', 'E'
##
## No pre-processing
## Resampling: Bootstrapped (25 reps)
## Summary of sample sizes: 11776, 11776, 11776, 11776, 11776, 11776, ...
## Resampling results across tuning parameters:
##
##   cp          Accuracy    Kappa
## 0.02414570  0.5800590  0.46311052
## 0.03913147  0.4935699  0.33978014
## 0.11948268  0.3179167  0.05125749
##
## Accuracy was used to select the optimal model using the largest value.
## The final value used for the model was cp = 0.0241457.
fancyRpartPlot(mod_rpt$finalModel)
```



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```
pred_rpt<-predict(mod_rpt,newdata=dt_testing)
confusionMatrix(pred_rpt,dt_testing$classe)
```

## Confusion Matrix and Statistics

##

## Reference

Prediction	A	B	C	D	E
A	1352	234	36	71	22
B	310	946	127	410	374
C	516	323	1186	482	369
D	17	15	19	323	22
E	37	0	0	0	655

##

## Overall Statistics

##

## Accuracy : 0.5687  
 ## 95% CI : (0.5577, 0.5797)  
 ## No Information Rate : 0.2845  
 ## P-Value [Acc > NIR] : < 2.2e-16

##

## Kappa : 0.4582  
 ## McNemar's Test P-Value : < 2.2e-16

##

## Statistics by Class:

##

## Class: A Class: B Class: C Class: D Class: E

```
## Sensitivity      0.6057  0.6232  0.8670  0.25117  0.45423
## Specificity      0.9353  0.8070  0.7391  0.98887  0.99422
## Pos Pred Value   0.7883  0.4365  0.4124  0.81566  0.94653
## Neg Pred Value    0.8565  0.8993  0.9634  0.87074  0.88999
## Prevalence       0.2845  0.1935  0.1744  0.16391  0.18379
## Detection Rate    0.1723  0.1206  0.1512  0.04117  0.08348
## Detection Prevalence 0.2186  0.2762  0.3666  0.05047  0.08820
## Balanced Accuracy 0.7705  0.7151  0.8030  0.62002  0.72423
```

## Linear Discriminant (lda)

```
mod_lda<-train(classe~.,data=dt_training,method="lda",verbose=FALSE)
```

```
## Loading required package: MASS
```

```
print(mod_lda)
```

```
## Linear Discriminant Analysis
##
## 11776 samples
##    52 predictor
##    5 classes: 'A', 'B', 'C', 'D', 'E'
##
## No pre-processing
## Resampling: Bootstrapped (25 reps)
## Summary of sample sizes: 11776, 11776, 11776, 11776, 11776, 11776, ...
## Resampling results:
##
##    Accuracy  Kappa
##    0.6997    0.6201197
```

```
pred_lda<-predict(mod_lda,newdata=dt_testing)
confusionMatrix(pred_lda,dt_testing$classe)
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    A    B    C    D    E
##      A 1834  230  131   85   50
##      B   47  973  115   46  272
##      C   177  188  913  152  157
##      D   165   61  174  954  135
##      E     9   66   35   49  828
##
## Overall Statistics
##
##              Accuracy : 0.7012
##              95% CI : (0.691, 0.7114)
##      No Information Rate : 0.2845
##      P-Value [Acc > NIR] : < 2.2e-16
##
##              Kappa : 0.6219
##      McNemar's Test P-Value : < 2.2e-16
##
```

```
## Statistics by Class:
##
##           Class: A Class: B Class: C Class: D Class: E
## Sensitivity      0.8217  0.6410  0.6674  0.7418  0.5742
## Specificity      0.9116  0.9241  0.8960  0.9184  0.9752
## Pos Pred Value   0.7871  0.6696  0.5753  0.6407  0.8389
## Neg Pred Value   0.9278  0.9148  0.9273  0.9478  0.9105
## Prevalence       0.2845  0.1935  0.1744  0.1639  0.1838
## Detection Rate   0.2337  0.1240  0.1164  0.1216  0.1055
## Detection Prevalence 0.2970 0.1852 0.2023 0.1898 0.1258
## Balanced Accuracy 0.8667  0.7826  0.7817  0.8301  0.7747
```

## Support Vector Machines (svm)

```
mod_svm<-svm(classe~.,data=dt_training)
print(mod_svm)

##
## Call:
## svm(formula = classe ~ ., data = dt_training)
##
##
## Parameters:
##   SVM-Type:  C-classification
## SVM-Kernel:  radial
##      cost:   1
##   gamma:    0.01923077
##
## Number of Support Vectors:  5754

pred_svm<-predict(mod_svm,newdata=dt_testing)
confusionMatrix(pred_svm,dt_testing$classe)$overall[4]

## AccuracyUpper
##      0.9490314
```

As we can see using different algorithms to predict and comparing the accuracy of each one Random Forest it's the most accuracy with a 99%.

	Accuracy	Kappa	AccuracyLower	AccuracyUpper
Random Forest	0.9933724	0.9916168	0.9913178	0.9950464
Cran RPart	0.5686974	0.4581549	0.5576512	0.5796925
LDA	0.7012490	0.6219291	0.6909841	0.7113643
SVM	0.9440479	0.9291198	0.9387315	0.9490314

## Predicts on Testing Set

Now using Random Forest to predict the outcome of the testing set

```
pred_testing<-predict(mod_rf,testing_data,type="class")
print(pred_testing)

##  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  
pred_df<-data.frame(pred_testing)  
write.csv(pred_df,file="./data/predicts.csv",row.names=FALSE)
```