

PML Project Work

Abhishek Kaul

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Weight Lifting Assingment

load the datapackages and download the file

```
library(caret)
```

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

```
library(ggplot2)
library(rpart)
library(knitr)

# get the csv file frm weblink & read the file
##fileurl<- "https://d396qusza40orc.cloudfront.net/predmachLearn/pml-training.csv"
##download.file(fileurl, destfile="pml.csv")
##fileurl<- "https://d396qusza40orc.cloudfront.net/predmachLearn/pml-testing.csv"
##download.file(fileurl, destfile="test.csv")
```

get familiar with data

```
pml <- read.csv("pml.csv")
head(pml, n=2)
```

```
##   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
##   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
##   kurtosis_roll_belt kurtosis_pitch_belt kurtosis_yaw_belt
## 1
## 2
##   skewness_roll_belt skewness_roll_belt.1 skewness_yaw_belt max_roll_belt
## 1                               NA
## 2                               NA
##   max_pitch_belt max_yaw_belt min_roll_belt min_pitch_belt min_yaw_belt
```

```

## 1          NA          NA          NA
## 2          NA          NA          NA
##   amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
## 1          NA          NA          NA
## 2          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
##   avg_pitch_belt stddev_pitch_belt var_pitch_belt avg_yaw_belt
## 1          NA          NA          NA          NA
## 2          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     -0.02
## 2          NA          NA      0.02      0     -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
##   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
##   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
##   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
##   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
##   magnet_arm_y magnet_arm_z kurtosis_roll_arm kurtosis_pictch_arm
## 1        337        516
## 2        337        513
##   kurtosis_yaw_arm skewness_roll_arm skewness_pitch_arm skewness_yaw_arm
## 1
## 2
##   max_roll_arm max_pictch_arm max_yaw_arm min_roll_arm min_pitch_arm
## 1          NA          NA          NA          NA          NA
## 2          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
##   roll_dumbbell pitch_dumbbell yaw_dumbbell kurtosis_roll_dumbbell
## 1      13.05217     -70.49400    -84.87394
## 2      13.13074     -70.63751    -84.71065
##   kurtosis_pictch_dumbbell kurtosis_yaw_dumbbell skewness_roll_dumbbell
## 1
## 2
##   skewness_pitch_dumbbell skewness_yaw_dumbbell max_roll_dumbbell
## 1
## 2

```

```

##  max_pictch_dumbbell max_yaw_dumbbell min_roll_dumbbell min_pitch_dumbbell
## 1          NA          NA          NA
## 2          NA          NA          NA
##  min_yaw_dumbbell amplitude_roll_dumbbell amplitude_pitch_dumbbell
## 1          NA          NA
## 2          NA          NA
##  amplitude_yaw_dumbbell total_accel_dumbbell var_accel_dumbbell
## 1          37          NA
## 2          37          NA
##  avg_roll_dumbbell stddev_roll_dumbbell var_roll_dumbbell
## 1          NA          NA          NA
## 2          NA          NA          NA
##  avg_pitch_dumbbell stddev_pitch_dumbbell var_pitch_dumbbell
## 1          NA          NA          NA
## 2          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
##  gyros_dumbbell_y gyros_dumbbell_z accel_dumbbell_x accel_dumbbell_y
## 1      -0.02          0        -234         47
## 2      -0.02          0        -233         47
##  accel_dumbbell_z magnet_dumbbell_x magnet_dumbbell_y magnet_dumbbell_z
## 1      -271        -559        293        -65
## 2      -269        -555        296        -64
##  roll_forearm pitch_forearm yaw_forearm kurtosis_roll_forearm
## 1      28.4       -63.9       -153
## 2      28.3       -63.9       -153
##  kurtosis_pictch_forearm kurtosis_yaw_forearm skewness_roll_forearm
## 1
## 2
##  skewness_pitch_forearm skewness_yaw_forearm max_roll_forearm
## 1                      NA
## 2                      NA
##  max_pictch_forearm max_yaw_forearm min_roll_forearm min_pitch_forearm
## 1          NA          NA          NA
## 2          NA          NA          NA
##  min_yaw_forearm amplitude_roll_forearm amplitude_pitch_forearm
## 1          NA          NA
## 2          NA          NA
##  amplitude_yaw_forearm total_accel_forearm var_accel_forearm
## 1          36          NA
## 2          36          NA
##  avg_roll_forearm stddev_roll_forearm var_roll_forearm avg_pitch_forearm
## 1          NA          NA          NA          NA
## 2          NA          NA          NA          NA
##  stddev_pitch_forearm var_pitch_forearm avg_yaw_forearm
## 1          NA          NA          NA
## 2          NA          NA          NA
##  stddev_yaw_forearm var_yaw_forearm gyros_forearm_x gyros_forearm_y
## 1          NA          NA          0.03          0

```

```

## 2           NA           NA        0.02          0
##   gyros_forearm_z accel_forearm_x accel_forearm_y accel_forearm_z
## 1      -0.02         192         203       -215
## 2      -0.02         192         203       -216
##   magnet_forearm_x magnet_forearm_y magnet_forearm_z classe
## 1      -17         654         476        A
## 2      -18         661         473        A

```

```
summary(pml)
```

```

##      X           user_name raw_timestamp_part_1 raw_timestamp_part_2
##  Min. : 1    adelmo :3892     Min.  :1.322e+09     Min.  : 294
##  1st Qu.: 4906 carlitos:3112   1st Qu.:1.323e+09   1st Qu.:252912
##  Median : 9812 charles :3536   Median :1.323e+09   Median :496380
##  Mean   : 9812 eurico  :3070   Mean   :1.323e+09   Mean   :500656
##  3rd Qu.:14717 jeremy  :3402   3rd Qu.:1.323e+09   3rd Qu.:751891
##  Max.  :19622 pedro   :2610   Max.   :1.323e+09   Max.   :998801
##
##      cvtd_timestamp new_window num_window roll_belt
##  28/11/2011 14:14: 1498 no      :19216   Min.   : 1.0  Min.  :-28.90
##  05/12/2011 11:24: 1497 yes     : 406   1st Qu.:222.0 1st Qu.: 1.10
##  30/11/2011 17:11: 1440                Median :424.0  Median :113.00
##  05/12/2011 11:25: 1425                Mean   :430.6  Mean   : 64.41
##  02/12/2011 14:57: 1380                3rd Qu.:644.0  3rd Qu.:123.00
##  02/12/2011 13:34: 1375                Max.   :864.0  Max.   :162.00
##  (Other)      :11007
##      pitch_belt      yaw_belt total_accel_belt kurtosis_roll_belt
##  Min.  : -55.8000  Min.  :-180.00  Min.   : 0.00      :19216
##  1st Qu.:  1.7600  1st Qu.: -88.30  1st Qu.: 3.00      #DIV/0! : 10
##  Median :  5.2800  Median : -13.00  Median :17.00      -1.908453:  2
##  Mean   :  0.3053  Mean   : -11.21  Mean   :11.31      -0.016850:  1
##  3rd Qu.: 14.9000  3rd Qu.: 12.90  3rd Qu.:18.00      -0.021024:  1
##  Max.   : 60.3000  Max.   : 179.00  Max.   :29.00      -0.025513:  1
##  (Other)      : 391
##      kurtosis_pictch_belt kurtosis_yaw_belt skewness_roll_belt
##  :19216                 :19216                 :19216
##  #DIV/0! : 32      #DIV/0!: 406      #DIV/0! : 9
##  47.000000: 4                  0.000000 : 4
##  -0.150950: 3                  0.422463 : 2
##  -0.684748: 3                  -0.003095: 1
##  -1.750749: 3                  -0.010002: 1
##  (Other) : 361                  (Other) : 389
##      skewness_roll_belt.1 skewness_yaw_belt max_roll_belt      max_pictch_belt
##  :19216                 :19216      Min.  :-94.300  Min.  : 3.00
##  #DIV/0! : 32      #DIV/0!: 406      1st Qu.: -88.000 1st Qu.: 5.00
##  0.000000 : 4                  Median : -5.100  Median :18.00
##  -2.156553: 3                  Mean   : -6.667  Mean   :12.92
##  -3.072669: 3                  3rd Qu.: 18.500  3rd Qu.:19.00
##  -6.324555: 3                  Max.   :180.000  Max.   :30.00

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## (Other) : 361                               NA's :19216      NA's :19216
## max_yaw_belt    min_roll_belt    min_pitch_belt    min_yaw_belt
##          :19216   Min.   :-180.00   Min.   : 0.00      :19216
## -1.1   : 30    1st Qu.: -88.40   1st Qu.: 3.00   -1.1   : 30
## -1.4   : 29    Median : -7.85   Median :16.00   -1.4   : 29
## -1.2   : 26    Mean   : -10.44   Mean   :10.76   -1.2   : 26
## -0.9   : 24    3rd Qu.:  9.05   3rd Qu.:17.00   -0.9   : 24
## -1.3   : 22    Max.   : 173.00   Max.   :23.00   -1.3   : 22
## (Other): 275   NA's   :19216   NA's   :19216 (Other): 275
## amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
## Min.   : 0.000   Min.   : 0.000      :19216
## 1st Qu.: 0.300   1st Qu.: 1.000      #DIV/0!: 10
## Median : 1.000   Median : 1.000      0.00   : 12
## Mean   : 3.769   Mean   : 2.167      0.0000 : 384
## 3rd Qu.: 2.083   3rd Qu.: 2.000
## Max.   :360.000   Max.   :12.000
## NA's   :19216   NA's   :19216
## var_total_accel_belt avg_roll_belt stddev_roll_belt var_roll_belt
## Min.   : 0.000   Min.   :-27.40   Min.   : 0.000   Min.   : 0.000
## 1st Qu.: 0.100   1st Qu.: 1.10   1st Qu.: 0.200   1st Qu.: 0.000
## Median : 0.200   Median :116.35   Median : 0.400   Median : 0.100
## Mean   : 0.926   Mean   : 68.06   Mean   : 1.337   Mean   : 7.699
## 3rd Qu.: 0.300   3rd Qu.:123.38   3rd Qu.: 0.700   3rd Qu.: 0.500
## Max.   :16.500   Max.   :157.40   Max.   :14.200   Max.   :200.700
## NA's   :19216   NA's   :19216   NA's   :19216   NA's   :19216
## avg_pitch_belt stddev_pitch_belt var_pitch_belt avg_yaw_belt
## Min.   :-51.400  Min.   :0.000   Min.   : 0.000   Min.   :-138.300
## 1st Qu.: 2.025   1st Qu.:0.200   1st Qu.: 0.000   1st Qu.: -88.175
## Median : 5.200   Median :0.400   Median : 0.100   Median : -6.550
## Mean   : 0.520   Mean   :0.603   Mean   : 0.766   Mean   : -8.831
## 3rd Qu.: 15.775  3rd Qu.:0.700   3rd Qu.: 0.500   3rd Qu.: 14.125
## Max.   : 59.700  Max.   :4.000   Max.   :16.200   Max.   : 173.500
## NA's   :19216   NA's   :19216   NA's   :19216   NA's   :19216
## stddev_yaw_belt var_yaw_belt gyros_belt_x
## Min.   : 0.000   Min.   : 0.000   Min.   :-1.040000
## 1st Qu.: 0.100   1st Qu.: 0.010   1st Qu.:-0.030000
## Median : 0.300   Median : 0.090   Median : 0.030000
## Mean   : 1.341   Mean   : 107.487  Mean   :-0.005592
## 3rd Qu.: 0.700   3rd Qu.: 0.475   3rd Qu.: 0.110000
## Max.   :176.600  Max.   :31183.240  Max.   : 2.220000
## NA's   :19216   NA's   :19216
## gyros_belt_y gyros_belt_z accel_belt_x accel_belt_y
## Min.   :-0.64000  Min.   :-1.4600  Min.   :-120.000  Min.   :-69.00
## 1st Qu.: 0.00000  1st Qu.:-0.2000 1st Qu.: -21.000  1st Qu.:  3.00
## Median : 0.02000  Median :-0.1000  Median : -15.000  Median : 35.00
## Mean   : 0.03959  Mean   :-0.1305  Mean   : -5.595  Mean   : 30.15
## 3rd Qu.: 0.11000  3rd Qu.:-0.0200 3rd Qu.: -5.000  3rd Qu.: 61.00
## Max.   : 0.64000  Max.   : 1.6200  Max.   : 85.000  Max.   :164.00
##
## accel_belt_z magnet_belt_x magnet_belt_y magnet_belt_z

```

```

## Min.   :-275.00  Min.   :-52.0  Min.   :354.0  Min.   :-623.0
## 1st Qu.:-162.00 1st Qu.: 9.0   1st Qu.:581.0  1st Qu.:-375.0
## Median :-152.00  Median : 35.0  Median :601.0  Median :-320.0
## Mean   :-72.59   Mean   : 55.6  Mean   :593.7  Mean   :-345.5
## 3rd Qu.: 27.00   3rd Qu.: 59.0  3rd Qu.:610.0  3rd Qu.:-306.0
## Max.   :105.00   Max.   :485.0  Max.   :673.0  Max.   : 293.0
##
##      roll_arm       pitch_arm       yaw_arm       total_accel_arm
## Min.   :-180.00  Min.   :-88.800  Min.   :-180.0000  Min.   : 1.00
## 1st Qu.:-31.77  1st Qu.:-25.900  1st Qu.:-43.1000  1st Qu.:17.00
## Median : 0.00   Median : 0.000   Median : 0.0000  Median :27.00
## Mean   : 17.83  Mean   : -4.612  Mean   : -0.6188  Mean   :25.51
## 3rd Qu.: 77.30  3rd Qu.: 11.200  3rd Qu.: 45.8750  3rd Qu.:33.00
## Max.   :180.00   Max.   : 88.500  Max.   :180.0000  Max.   :66.00
##
##      var_accel_arm    avg_roll_arm    stddev_roll_arm  var_roll_arm
## Min.   : 0.00   Min.   :-166.67   Min.   : 0.000   Min.   : 0.000
## 1st Qu.: 9.03   1st Qu.: -38.37   1st Qu.: 1.376   1st Qu.: 1.898
## Median : 40.61   Median :  0.00   Median : 5.702   Median : 32.517
## Mean   : 53.23   Mean   : 12.68   Mean   :11.201   Mean   :417.264
## 3rd Qu.: 75.62   3rd Qu.: 76.33   3rd Qu.:14.921   3rd Qu.:222.647
## Max.   :331.70   Max.   :163.33   Max.   :161.964   Max.   :26232.208
## NA's   :19216    NA's   :19216    NA's   :19216    NA's   :19216
##      avg_pitch_arm    stddev_pitch_arm  var_pitch_arm  avg_yaw_arm
## Min.   :-81.773  Min.   : 0.000   Min.   : 0.000   Min.   :-173.440
## 1st Qu.:-22.770  1st Qu.: 1.642   1st Qu.: 2.697   1st Qu.: -29.198
## Median : 0.000   Median : 8.133   Median : 66.146   Median : 0.000
## Mean   : -4.901  Mean   :10.383   Mean   :195.864   Mean   : 2.359
## 3rd Qu.: 8.277   3rd Qu.:16.327   3rd Qu.:266.576   3rd Qu.: 38.185
## Max.   : 75.659  Max.   :43.412   Max.   :1884.565   Max.   : 152.000
## NA's   :19216    NA's   :19216    NA's   :19216    NA's   :19216
##      stddev_yaw_arm    var_yaw_arm     gyros_arm_x
## Min.   : 0.000   Min.   : 0.000   Min.   :-6.37000
## 1st Qu.: 2.577   1st Qu.: 6.642   1st Qu.:-1.33000
## Median : 16.682  Median : 278.309  Median : 0.08000
## Mean   : 22.270  Mean   :1055.933  Mean   : 0.04277
## 3rd Qu.: 35.984  3rd Qu.:1294.850  3rd Qu.: 1.57000
## Max.   :177.044  Max.   :31344.568  Max.   : 4.87000
## NA's   :19216    NA's   :19216
##      gyros_arm_y     gyros_arm_z     accel_arm_x     accel_arm_y
## Min.   :-3.4400   Min.   :-2.3300   Min.   :-404.00  Min.   :-318.0
## 1st Qu.:-0.8000  1st Qu.:-0.0700  1st Qu.:-242.00  1st Qu.: -54.0
## Median :-0.2400  Median : 0.2300   Median : -44.00  Median : 14.0
## Mean   :-0.2571  Mean   : 0.2695   Mean   : -60.24  Mean   : 32.6
## 3rd Qu.: 0.1400  3rd Qu.: 0.7200   3rd Qu.: 84.00   3rd Qu.:139.0
## Max.   : 2.8400   Max.   : 3.0200   Max.   : 437.00  Max.   : 308.0
##
##      accel_arm_z     magnet_arm_x    magnet_arm_y    magnet_arm_z
## Min.   :-636.00   Min.   :-584.0   Min.   :-392.0   Min.   :-597.0
## 1st Qu.:-143.00  1st Qu.:-300.0  1st Qu.: -9.0   1st Qu.: 131.2

```

```

## Median : -47.00  Median : 289.0  Median : 202.0  Median : 444.0
## Mean   : -71.25  Mean   : 191.7  Mean   : 156.6  Mean   : 306.5
## 3rd Qu.: 23.00   3rd Qu.: 637.0  3rd Qu.: 323.0  3rd Qu.: 545.0
## Max.   : 292.00  Max.   : 782.0  Max.   : 583.0  Max.   : 694.0
##
## kurtosis_roll_arm kurtosis_pitch_arm kurtosis_yaw_arm skewness_roll_arm
##          :19216           :19216           :19216           :19216
## #DIV/0! : 78    #DIV/0! : 80    #DIV/0! : 11    #DIV/0! : 77
## -0.02438: 1     -0.00484: 1     0.55844 : 2     -0.00051: 1
## -0.04190: 1     -0.01311: 1     0.65132 : 2     -0.00696: 1
## -0.05051: 1     -0.02967: 1     -0.01548: 1     -0.01884: 1
## -0.05695: 1     -0.07394: 1     -0.01749: 1     -0.03359: 1
## (Other) : 324   (Other) : 322   (Other) : 389   (Other) : 325
## skewness_pitch_arm skewness_yaw_arm max_roll_arm max_pitch_arm
##          :19216           :19216      Min.   :-73.100  Min.   :-173.000
## #DIV/0! : 80    #DIV/0! : 11    1st Qu.: -0.175  1st Qu.: -1.975
## -0.00184: 1     -1.62032: 2     Median : 4.950  Median : 23.250
## -0.01185: 1     0.55053 : 2     Mean   : 11.236  Mean   : 35.751
## -0.01247: 1     -0.00311: 1     3rd Qu.: 26.775  3rd Qu.: 95.975
## -0.02063: 1     -0.00562: 1     Max.   : 85.500  Max.   : 180.000
## (Other) : 322   (Other) : 389   NA's   :19216   NA's   :19216
## max_yaw_arm min_roll_arm min_pitch_arm min_yaw_arm
## Min.   : 4.00   Min.   :-89.10   Min.   :-180.00  Min.   : 1.00
## 1st Qu.:29.00   1st Qu.:-41.98   1st Qu.: -72.62  1st Qu.: 8.00
## Median :34.00   Median :-22.45   Median : -33.85  Median :13.00
## Mean   :35.46   Mean   :-21.22   Mean   : -33.92  Mean   :14.66
## 3rd Qu.:41.00   3rd Qu.:  0.00   3rd Qu.:  0.00   3rd Qu.:19.00
## Max.   :65.00   Max.   : 66.40   Max.   : 152.00  Max.   :38.00
## NA's   :19216   NA's   :19216   NA's   :19216   NA's   :19216
## amplitude_roll_arm amplitude_pitch_arm amplitude_yaw_arm
## Min.   : 0.000   Min.   : 0.000   Min.   : 0.00
## 1st Qu.: 5.425   1st Qu.: 9.925   1st Qu.:13.00
## Median :28.450   Median : 54.900   Median :22.00
## Mean   :32.452   Mean   : 69.677   Mean   :20.79
## 3rd Qu.:50.960   3rd Qu.:115.175   3rd Qu.:28.75
## Max.   :119.500   Max.   :360.000   Max.   :52.00
## NA's   :19216   NA's   :19216   NA's   :19216
## roll_dumbbell pitch_dumbbell yaw_dumbbell
## Min.   :-153.71  Min.   :-149.59  Min.   :-150.871
## 1st Qu.: -18.49  1st Qu.: -40.89  1st Qu.: -77.644
## Median : 48.17   Median : -20.96  Median : -3.324
## Mean   : 23.84   Mean   : -10.78  Mean   : 1.674
## 3rd Qu.: 67.61   3rd Qu.: 17.50   3rd Qu.: 79.643
## Max.   : 153.55  Max.   : 149.40  Max.   : 154.952
##
## kurtosis_roll_dumbbell kurtosis_pitch_dumbbell kurtosis_yaw_dumbbell
##          :19216           :19216           :19216
## #DIV/0!: 5       -0.5464: 2       #DIV/0!: 406
## -0.2583: 2       -0.9334: 2
## -0.3705: 2       -2.0833: 2

```

```

## -0.5855: 2      -2.0851: 2
## -2.0851: 2      -2.0889: 2
## (Other): 393      (Other): 396
## skewness_roll_dumbbell skewness_pitch_dumbbell skewness_yaw_dumbbell
## :19216           :19216           :19216
## #DIV/0!: 4      -0.2328: 2      #DIV/0!: 406
## -0.9324: 2      -0.3521: 2
## 0.1110 : 2      -0.7036: 2
## 1.0312 : 2      0.1090 : 2
## -0.0082: 1      1.0326 : 2
## (Other): 395      (Other): 396
## max_roll_dumbbell max_pitch_dumbbell max_yaw_dumbbell min_roll_dumbbell
## Min. : -70.10   Min. : -112.90       :19216   Min. : -149.60
## 1st Qu.: -27.15  1st Qu.: -66.70     -0.6 : 20    1st Qu.: -59.67
## Median : 14.85   Median : 40.05      0.2 : 19    Median : -43.55
## Mean   : 13.76   Mean   : 32.75     -0.8 : 18    Mean   : -41.24
## 3rd Qu.: 50.58   3rd Qu.: 133.22    -0.3 : 16    3rd Qu.: -25.20
## Max.   : 137.00  Max.   : 155.00    -0.2 : 15    Max.   : 73.20
## NA's   :19216    NA's   :19216      (Other): 318   NA's   :19216
## min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dumbbell
## Min. : -147.00   :19216   Min. : 0.00
## 1st Qu.: -91.80   -0.6 : 20    1st Qu.: 14.97
## Median : -66.15   0.2 : 19    Median : 35.05
## Mean   : -33.18   -0.8 : 18    Mean   : 55.00
## 3rd Qu.: 21.20    -0.3 : 16    3rd Qu.: 81.04
## Max.   : 120.90   -0.2 : 15    Max.   : 256.48
## NA's   :19216    (Other): 318   NA's   :19216
## amplitude_pitch_dumbbell amplitude_yaw_dumbbell total_accel_dumbbell
## Min. : 0.00       :19216   Min. : 0.00
## 1st Qu.: 17.06    #DIV/0!: 5     1st Qu.: 4.00
## Median : 41.73    0.00 : 401    Median : 10.00
## Mean   : 65.93    (Other): 401   Mean   : 13.72
## 3rd Qu.: 99.55    (Other): 401   3rd Qu.: 19.00
## Max.   : 273.59    (Other): 401   Max.   : 58.00
## NA's   :19216
## var_accel_dumbbell avg_roll_dumbbell stddev_roll_dumbbell
## Min. : 0.000   Min. : -128.96  Min. : 0.000
## 1st Qu.: 0.378   1st Qu.: -12.33  1st Qu.: 4.639
## Median : 1.000   Median : 48.23   Median : 12.204
## Mean   : 4.388   Mean   : 23.86   Mean   : 20.761
## 3rd Qu.: 3.434   3rd Qu.: 64.37   3rd Qu.: 26.356
## Max.   : 230.428 Max.   : 125.99  Max.   : 123.778
## NA's   :19216    NA's   :19216  NA's   :19216
## var_roll_dumbbell avg_pitch_dumbbell stddev_pitch_dumbbell
## Min. : 0.00   Min. : -70.73  Min. : 0.000
## 1st Qu.: 21.52  1st Qu.: -42.00  1st Qu.: 3.482
## Median : 148.95 Median : -19.91  Median : 8.089
## Mean   : 1020.27 Mean   : -12.33  Mean   : 13.147
## 3rd Qu.: 694.65 3rd Qu.: 13.21   3rd Qu.: 19.238
## Max.   : 15321.01 Max.   : 94.28   Max.   : 82.680

```

```

## NA's :19216      NA's :19216      NA's :19216
## var_pitch_dumbbell avg_yaw_dumbbell stddev_yaw_dumbbell
## Min. : 0.00      Min. :-117.950   Min. : 0.000
## 1st Qu.: 12.12    1st Qu.: -76.696  1st Qu.: 3.885
## Median : 65.44    Median : -4.505   Median : 10.264
## Mean   : 350.31   Mean   : 0.202   Mean   : 16.647
## 3rd Qu.: 370.11   3rd Qu.: 71.234   3rd Qu.: 24.674
## Max.  :6836.02   Max.  :134.905   Max.  :107.088
## NA's :19216      NA's :19216      NA's :19216
## var_yaw_dumbbell gyros_dumbbell_x gyros_dumbbell_y
## Min. : 0.00      Min. :-204.0000  Min. :-2.10000
## 1st Qu.: 15.09   1st Qu.: -0.0300  1st Qu.: -0.14000
## Median : 105.35  Median : 0.1300  Median : 0.03000
## Mean   : 589.84  Mean   : 0.1611  Mean   : 0.04606
## 3rd Qu.: 608.79  3rd Qu.: 0.3500  3rd Qu.: 0.21000
## Max.  :11467.91  Max.  : 2.2200  Max.  :52.00000
## NA's :19216
## gyros_dumbbell_z accel_dumbbell_x accel_dumbbell_y accel_dumbbell_z
## Min. : -2.380   Min. :-419.00   Min. :-189.00   Min. :-334.00
## 1st Qu.: -0.310  1st Qu.: -50.00   1st Qu.: -8.00   1st Qu.: -142.00
## Median : -0.130  Median : -8.00   Median : 41.50   Median : -1.00
## Mean   : -0.129  Mean   : -28.62  Mean   : 52.63   Mean   : -38.32
## 3rd Qu.:  0.030  3rd Qu.: 11.00   3rd Qu.: 111.00  3rd Qu.: 38.00
## Max.  :317.000   Max.  : 235.00  Max.  : 315.00  Max.  : 318.00
##
## magnet_dumbbell_x magnet_dumbbell_y magnet_dumbbell_z roll_forearm
## Min. : -643.0   Min. : -3600    Min. : -262.00  Min. : -180.0000
## 1st Qu.: -535.0  1st Qu.: 231     1st Qu.: -45.00  1st Qu.: -0.7375
## Median : -479.0  Median : 311     Median : 13.00   Median : 21.7000
## Mean   : -328.5  Mean   : 221     Mean   : 46.05   Mean   : 33.8265
## 3rd Qu.: -304.0  3rd Qu.: 390     3rd Qu.: 95.00   3rd Qu.: 140.0000
## Max.  : 592.0   Max.  : 633     Max.  : 452.00  Max.  : 180.0000
##
## pitch_forearm     yaw_forearm     kurtosis_roll_forearm
## Min. : -72.50    Min. : -180.00   :19216
## 1st Qu.:  0.00    1st Qu.: -68.60  #DIV/0!: 84
## Median :  9.24    Median :  0.00  -0.8079: 2
## Mean   : 10.71    Mean   : 19.21  -0.9169: 2
## 3rd Qu.: 28.40    3rd Qu.: 110.00 -0.0227: 1
## Max.  : 89.80    Max.  : 180.00 -0.0359: 1
## (Other): 316
##
## kurtosis_pitch_forearm kurtosis_yaw_forearm skewness_roll_forearm
## :19216                  :19216                  :19216
## #DIV/0!: 85             #DIV/0!: 406            #DIV/0!: 83
## -0.0073: 1              -0.1912: 2
## -0.0442: 1              -0.4126: 2
## -0.0489: 1              -0.0004: 1
## -0.0523: 1              -0.0013: 1
## (Other): 317             (Other): 317
## skewness_pitch_forearm skewness_yaw_forearm max_roll_forearm

```

```

##          :19216          :19216      Min.   :-66.60
## #DIV/0!: 85          #DIV/0!: 406    1st Qu.:  0.00
## 0.0000 : 4                      Median : 26.80
## -0.6992: 2                      Mean   : 24.49
## -0.0113: 1                      3rd Qu.: 45.95
## -0.0131: 1                      Max.   : 89.80
## (Other): 313                     NA's   :19216
## max_pictch_forearm max_yaw_forearm min_roll_forearm min_pitch_forearm
## Min.   :-151.00          :19216  Min.   :-72.500  Min.   :-180.00
## 1st Qu.:  0.00          #DIV/0!: 84  1st Qu.: -6.075  1st Qu.: -175.00
## Median : 113.00          -1.2   : 32   Median :  0.000  Median : -61.00
## Mean   : 81.49          -1.3   : 31   Mean   : -0.167  Mean   : -57.57
## 3rd Qu.: 174.75          -1.4   : 24   3rd Qu.: 12.075  3rd Qu.:  0.00
## Max.   : 180.00          -1.5   : 24   Max.   : 62.100  Max.   : 167.00
## NA's   :19216          (Other): 211  NA's   :19216  NA's   :19216
## min_yaw_forearm amplitude_roll_forearm amplitude_pitch_forearm
##          :19216  Min.   : 0.000  Min.   : 0.0
## #DIV/0!: 84   1st Qu.: 1.125  1st Qu.: 2.0
## -1.2   : 32   Median : 17.770  Median : 83.7
## -1.3   : 31   Mean   : 24.653  Mean   :139.1
## -1.4   : 24   3rd Qu.: 39.875  3rd Qu.:350.0
## -1.5   : 24   Max.   :126.000  Max.   :360.0
## (Other): 211  NA's   :19216  NA's   :19216
## amplitude_yaw_forearm total_accel_forearm var_accel_forearm
##          :19216  Min.   : 0.00  Min.   : 0.000
## #DIV/0!: 84   1st Qu.: 29.00  1st Qu.: 6.759
## 0.00   : 322  Median : 36.00  Median : 21.165
##          Mean   : 34.72  Mean   : 33.502
##          3rd Qu.: 41.00  3rd Qu.: 51.240
##          Max.   :108.00  Max.   :172.606
##          NA's   :19216
## avg_roll_forearm stddev_roll_forearm var_roll_forearm
## Min.   :-177.234  Min.   : 0.000  Min.   : 0.00
## 1st Qu.: -0.909  1st Qu.: 0.428  1st Qu.: 0.18
## Median : 11.172  Median : 8.030  Median : 64.48
## Mean   : 33.165  Mean   : 41.986  Mean   : 5274.10
## 3rd Qu.: 107.132 3rd Qu.: 85.373  3rd Qu.: 7289.08
## Max.   : 177.256  Max.   :179.171  Max.   :32102.24
## NA's   :19216    NA's   :19216  NA's   :19216
## avg_pitch_forearm stddev_pitch_forearm var_pitch_forearm
## Min.   :-68.17   Min.   : 0.000  Min.   : 0.000
## 1st Qu.:  0.00   1st Qu.: 0.336  1st Qu.: 0.113
## Median : 12.02  Median : 5.516  Median : 30.425
## Mean   : 11.79  Mean   : 7.977  Mean   : 139.593
## 3rd Qu.: 28.48  3rd Qu.:12.866  3rd Qu.: 165.532
## Max.   : 72.09  Max.   :47.745  Max.   :2279.617
## NA's   :19216    NA's   :19216  NA's   :19216
## avg_yaw_forearm stddev_yaw_forearm var_yaw_forearm gyros_forearm_x
## Min.   :-155.06  Min.   : 0.000  Min.   : 0.00  Min.   :-22.000
## 1st Qu.: -26.26  1st Qu.: 0.524  1st Qu.: 0.27  1st Qu.: -0.220

```

```

## Median : 0.00 Median : 24.743 Median : 612.21 Median : 0.050
## Mean : 18.00 Mean : 44.854 Mean : 4639.85 Mean : 0.158
## 3rd Qu.: 85.79 3rd Qu.: 85.817 3rd Qu.: 7368.41 3rd Qu.: 0.560
## Max. : 169.24 Max. : 197.508 Max. : 39009.33 Max. : 3.970
## NA's : 19216 NA's : 19216 NA's : 19216
## 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
##
##
```

```
names(pml)
```

```

## [1] "X"                      "user_name"
## [3] "raw_timestamp_part_1"    "raw_timestamp_part_2"
## [5] "cvted_timestamp"        "new_window"
## [7] "num_window"              "roll_belt"
## [9] "pitch_belt"              "yaw_belt"
## [11] "total_accel_belt"       "kurtosis_roll_belt"
## [13] "kurtosis_pitch_belt"    "kurtosis_yaw_belt"
## [15] "skewness_roll_belt"      "skewness_roll_belt.1"
## [17] "skewness_yaw_belt"       "max_roll_belt"
## [19] "max_pitch_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"
```

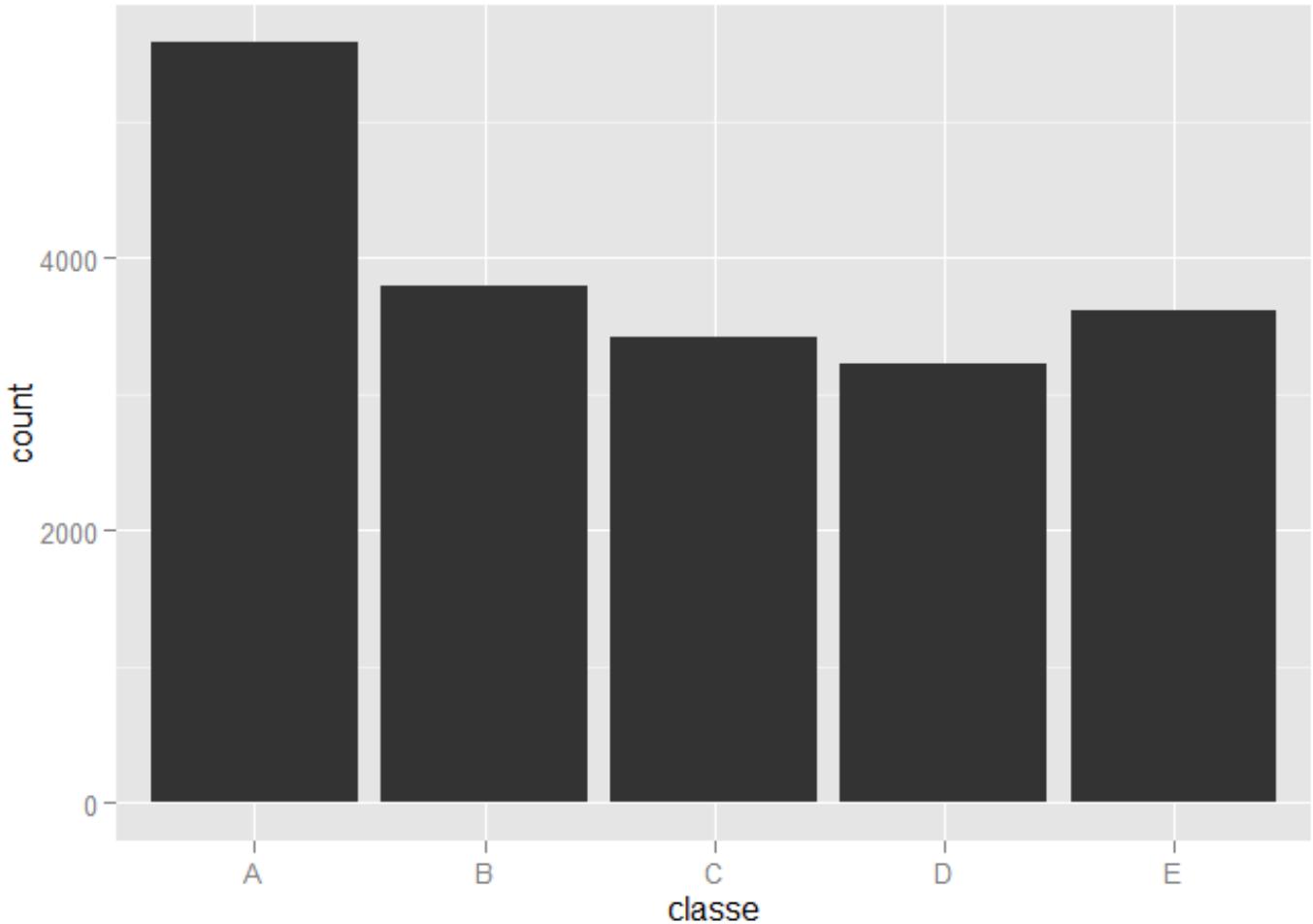
```

## [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_pitch_arm"
## [71] "kurtosis_yaw_arm"             "skewness_roll_arm"
## [73] "skewness_pitch_arm"            "skewness_yaw_arm"
## [75] "max_roll_arm"                  "max_pitch_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_pitch_dumbbell"
## [89] "kurtosis_yaw_dumbbell"          "skewness_roll_dumbbell"
## [91] "skewness_pitch_dumbbell"          "skewness_yaw_dumbbell"
## [93] "max_roll_dumbbell"                "max_pitch_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_pitch_forearm"
## [127] "kurtosis_yaw_forearm"              "skewness_roll_forearm"
## [129] "skewness_pitch_forearm"              "skewness_yaw_forearm"
## [131] "max_roll_forearm"                  "max_pitch_forearm"
## [133] "max_yaw_forearm"                  "min_roll_forearm"

```

```
## [135] "min_pitch_forearm"  
## [137] "amplitude_roll_forearm"  
## [139] "amplitude_yaw_forearm"  
## [141] "var_accel_forearm"  
## [143] "stddev_roll_forearm"  
## [145] "avg_pitch_forearm"  
## [147] "var_pitch_forearm"  
## [149] "stddev_yaw_forearm"  
## [151] "gyros_forearm_x"  
## [153] "gyros_forearm_z"  
## [155] "accel_forearm_y"  
## [157] "magnet_forearm_x"  
## [159] "magnet_forearm_z"  
"min_yaw_forearm"  
"amplitude_pitch_forearm"  
"total_accel_forearm"  
"avg_roll_forearm"  
"var_roll_forearm"  
"stddev_pitch_forearm"  
"avg_yaw_forearm"  
"var_yaw_forearm"  
"gyros_forearm_y"  
"accel_forearm_x"  
"accel_forearm_z"  
"magnet_forearm_y"  
"classe"
```

```
qplot(classe, data=pml)
```



```
table(complete.cases(pml))
```

```
##  
## FALSE TRUE  
## 19216 406
```

remove data elements like summations & averages

```
ignore <- "^(kurtosis|skewness|min|max|stddev|total|var|avg|ampl)"
data <- pml[,grep(ignore,names(pml),invert=T)]  
  
## checking complete cases
table(complete.cases(data))
```

```
##  
## TRUE  
## 19622
```

create a test & train dataset

```
data <- data[,grep("^(num_window|cvtd_timestamp|X|new_window)",names(data),invert=T)]
inTrain <- createDataPartition(y=data$classe, p=0.75, list=FALSE)
training <- data[inTrain,]
testing <- data[-inTrain,]  
  
train_predictors <- training[,-c(1,52)]
train_outcome <- training[,c(52)]
preProcess <- preProcess(train_predictors,method=c("center","scale","pca"),thresh=.95)
head(predict(preProcess, train_predictors))
```

```

##      PC1      PC2      PC3      PC4      PC5      PC6      PC7
## 1 2.741275 2.259464 -3.247763 1.283543 1.499243 -1.847151 -0.2264678
## 2 2.767969 2.289405 -3.257970 1.294004 1.584781 -1.909068 -0.2746385
## 3 2.769308 2.253998 -3.254136 1.285718 1.510750 -1.851174 -0.2513610
## 4 2.774875 2.284518 -3.240157 1.289582 1.516857 -1.903860 -0.2922527
## 5 2.821255 2.240022 -3.221949 1.283184 1.542017 -1.940652 -0.3035673
## 6 2.796585 2.261529 -3.254151 1.288457 1.513828 -1.878772 -0.2675670
##      PC8      PC9      PC10     PC11     PC12     PC13     PC14
## 1 2.790038 1.345366 -0.7571616 -1.1727080 -1.0616510 1.0798930 -1.446733
## 2 2.738465 1.363327 -0.7726788 -1.1424741 -1.0776604 1.1498515 -1.305247
## 3 2.752009 1.367446 -0.7648364 -1.1456931 -1.1422503 1.1515961 -1.357370
## 4 2.714596 1.381051 -0.7861436 -0.7715884 1.0843557 0.6572488 -1.987276
## 5 2.741546 1.354944 -0.8213824 -0.7214081 0.8041670 0.6360334 -1.903335
## 6 2.757362 1.381536 -0.7672444 -0.8662106 0.4844441 0.7538015 -1.846236
##      PC15     PC16     PC17     PC18     PC19     PC20
## 1 -1.388030 -1.500970 -0.3504184 0.3825246 -0.010548643 -1.264927
## 2 -1.427989 -1.475015 -0.3588466 0.3755539 0.023359040 -1.255491
## 3 -1.409029 -1.484043 -0.3498617 0.3773838 -0.005681196 -1.264032
## 4 -1.101234 -1.657116 -0.4248304 0.4379836 0.065374446 -1.285297
## 5 -1.108242 -1.689626 -0.3195766 0.4434883 0.080115031 -1.278499
## 6 -1.187697 -1.613424 -0.4001483 0.4306870 0.034639436 -1.269296
##      PC21     PC22     PC23     PC24
## 1 0.6630666 -0.13838213 0.5787333 -0.11891698
## 2 0.6416540 -0.09556899 0.5521123 -0.13460052
## 3 0.6418572 -0.11740884 0.5691335 -0.10114004
## 4 0.6479701 -0.11963934 0.5689323 -0.08223690
## 5 0.6630763 -0.12656752 0.5428495 -0.09596751
## 6 0.6579236 -0.12886388 0.5406306 -0.09601493

```

```

testing_predictors <- testing[,-c(1,52)]
testing_outcome <- testing[,c(52)]

```

Now lets make the prediction model

```

# use rpart
modelfitrpart <- train(train_outcome~., data=train_predictors, method="rpart")
modelfitrpart$results

```

```

##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04044432 0.5173083 0.37440153 0.05367449 0.08437247
## 2 0.05924238 0.4317581 0.23594191 0.06423181 0.10726937
## 3 0.11715561 0.3229251 0.06004234 0.04177226 0.06385977

```

```

# Use Lda
modelfitlda <- train(train_outcome~., data=train_predictors, method="lda")

```

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

```
modelfitlda$results
```

```
##   parameter Accuracy      Kappa AccuracySD      KappaSD
## 1       none 0.691011 0.6086832 0.004807837 0.00590465
```

```
# use rf
modelfitrf <- train(train_outcome~., data=train_predictors, method="rf")
```

```
## Loading required package: randomForest
```

```
## Warning: package 'randomForest' was built under R version 3.1.3
```

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

```
modelfitrf$results
```

```
##   mtry  Accuracy      Kappa AccuracySD      KappaSD
## 1     2 0.9939144 0.9923006 0.0014999152 0.001899862
## 2    26 0.9966401 0.9957497 0.0008791032 0.001112037
## 3    50 0.9926381 0.9906872 0.0026559256 0.003358674
```

```
# check for the testing set
confusionMatrix(predict(modelfitrf, testing_predictors), testing_outcome)
```

```

## Confusion Matrix and Statistics
##
##             Reference
## Prediction    A     B     C     D     E
##           A 1395     0     0     0     0
##           B     0  949     1     0     0
##           C     0     0  853     1     0
##           D     0     0     1  802     0
##           E     0     0     0     1  901
##
## Overall Statistics
##
##                 Accuracy : 0.9992
##                 95% CI : (0.9979, 0.9998)
##      No Information Rate : 0.2845
##      P-Value [Acc > NIR] : < 2.2e-16
##
##                 Kappa : 0.999
## McNemar's Test P-Value : NA
##
## Statistics by Class:
##
##                                Class: A Class: B Class: C Class: D Class: E
## Sensitivity                  1.0000   1.0000   0.9977   0.9975   1.0000
## Specificity                  1.0000   0.9997   0.9998   0.9998   0.9998
## Pos Pred Value                1.0000   0.9989   0.9988   0.9988   0.9989
## Neg Pred Value                1.0000   1.0000   0.9995   0.9995   1.0000
## Prevalence                   0.2845   0.1935   0.1743   0.1639   0.1837
## Detection Rate                0.2845   0.1935   0.1739   0.1635   0.1837
## Detection Prevalence          0.2845   0.1937   0.1741   0.1637   0.1839
## Balanced Accuracy              1.0000   0.9999   0.9987   0.9986   0.9999

```

Now calculating on test data

```

test <- read.csv("test.csv")
predict(modelfitrf,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

```