

# PML Project Work

*Abhishek Kaul*

*Saturday, March 21, 2015*

## 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")
```

## Step 2 - get familiar with data

```
pml <- read.csv("pml.csv")
head(pml)
```

```
##   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
## 3 3 carlitos      1323084231          820366 05/12/2011 11:23
## 4 4 carlitos      1323084232          120339 05/12/2011 11:23
## 5 5 carlitos      1323084232          196328 05/12/2011 11:23
## 6 6 carlitos      1323084232          304277 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
## 3         no       11     1.42      8.07    -94.4            3
## 4         no       12     1.48      8.05    -94.4            3
## 5         no       12     1.48      8.07    -94.4            3
```

```

## 6          no      12     1.45      8.06    -94.4      3
## kurtosis_roll_belt kurtosis_picth_belt kurtosis_yaw_belt
## 1
## 2
## 3
## 4
## 5
## 6
## skewness_roll_belt skewness_roll_belt.1 skewness_yaw_belt max_roll_belt
## 1                               NA
## 2                               NA
## 3                               NA
## 4                               NA
## 5                               NA
## 6                               NA
## max_picth_belt max_yaw_belt min_roll_belt min_pitch_belt min_yaw_belt
## 1          NA          NA          NA
## 2          NA          NA          NA
## 3          NA          NA          NA
## 4          NA          NA          NA
## 5          NA          NA          NA
## 6          NA          NA          NA
## amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
## 1          NA          NA
## 2          NA          NA
## 3          NA          NA
## 4          NA          NA
## 5          NA          NA
## 6          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
## 3          NA          NA          NA          NA
## 4          NA          NA          NA          NA
## 5          NA          NA          NA          NA
## 6          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
## 3          NA          NA          NA          NA
## 4          NA          NA          NA          NA
## 5          NA          NA          NA          NA
## 6          NA          NA          NA          NA
## stddev_yaw_belt var_yaw_belt gyros_belt_x gyros_belt_y gyros_belt_z
## 1          NA          NA        0.00        0.00      -0.02
## 2          NA          NA        0.02        0.00      -0.02
## 3          NA          NA        0.00        0.00      -0.02
## 4          NA          NA        0.02        0.00      -0.03
## 5          NA          NA        0.02        0.02      -0.02
## 6          NA          NA        0.02        0.00      -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
## 3      -20          5          23         -2        600
## 4      -22          3          21         -6        604
## 5      -21          2          24         -6        600
## 6      -21          4          21          0        603
##   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
## 3      -305       -128      22.5     -161        34       NA
## 4      -310       -128      22.1     -161        34       NA
## 5      -302       -128      22.1     -161        34       NA
## 6      -312       -128      22.0     -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
## 3          NA          NA          NA          NA          NA
## 4          NA          NA          NA          NA          NA
## 5          NA          NA          NA          NA          NA
## 6          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
## 3          NA          NA          NA          NA       0.02
## 4          NA          NA          NA          NA       0.02
## 5          NA          NA          NA          NA       0.00
## 6          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
## 3     -0.02     -0.02      -289       110      -126      -368
## 4     -0.03      0.02      -289       111      -123      -372
## 5     -0.03      0.00      -289       111      -123      -374
## 6     -0.03      0.00      -289       111      -122      -369
##   magnet_arm_y magnet_arm_z kurtosis_roll_arm kurtosis_pictch_arm
## 1      337       516
## 2      337       513
## 3      344       513
## 4      344       512
## 5      337       506
## 6      342       513
##   kurtosis_yaw_arm skewness_roll_arm skewness_pitch_arm skewness_yaw_arm
## 1
## 2
## 3
## 4
## 5
## 6
##   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
## 3      NA      NA      NA      NA      NA
## 4      NA      NA      NA      NA      NA
## 5      NA      NA      NA      NA      NA
## 6      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
## 3      NA          NA          NA          NA
## 4      NA          NA          NA          NA
## 5      NA          NA          NA          NA
## 6      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
## 3    12.85075   -70.27812   -85.14078
## 4    13.43120   -70.39379   -84.87363
## 5    13.37872   -70.42856   -84.85306
## 6    13.38246   -70.81759   -84.46500
##   kurtosis_pictb_dumbbell kurtosis_yaw_dumbbell skewness_roll_dumbbell
## 1
## 2
## 3
## 4
## 5
## 6
##   skewness_pitch_dumbbell skewness_yaw_dumbbell max_roll_dumbbell
## 1                               NA
## 2                               NA
## 3                               NA
## 4                               NA
## 5                               NA
## 6                               NA
##   max_pictb_dumbbell max_yaw_dumbbell min_roll_dumbbell min_pitch_dumbbell
## 1      NA          NA          NA          NA
## 2      NA          NA          NA          NA
## 3      NA          NA          NA          NA
## 4      NA          NA          NA          NA
## 5      NA          NA          NA          NA
## 6      NA          NA          NA          NA
##   min_yaw_dumbbell amplitude_roll_dumbbell amplitude_pitch_dumbbell
## 1                  NA          NA
## 2                  NA          NA
## 3                  NA          NA
## 4                  NA          NA
## 5                  NA          NA
## 6                  NA          NA
##   amplitude_yaw_dumbbell total_accel_dumbbell var_accel_dumbbell
## 1                               NA

```

```

## 2                      37          NA
## 3                      37          NA
## 4                      37          NA
## 5                      37          NA
## 6                      37          NA
## avg_roll_dumbbell stddev_roll_dumbbell var_roll_dumbbell
## 1          NA          NA          NA
## 2          NA          NA          NA
## 3          NA          NA          NA
## 4          NA          NA          NA
## 5          NA          NA          NA
## 6          NA          NA          NA
## avg_pitch_dumbbell stddev_pitch_dumbbell var_pitch_dumbbell
## 1          NA          NA          NA
## 2          NA          NA          NA
## 3          NA          NA          NA
## 4          NA          NA          NA
## 5          NA          NA          NA
## 6          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
## 3          NA          NA          NA          0
## 4          NA          NA          NA          0
## 5          NA          NA          NA          0
## 6          NA          NA          NA          0
## gyros_dumbbell_y gyros_dumbbell_z accel_dumbbell_x accel_dumbbell_y
## 1      -0.02       0.00     -234         47
## 2      -0.02       0.00     -233         47
## 3      -0.02       0.00     -232         46
## 4      -0.02      -0.02     -232         48
## 5      -0.02       0.00     -233         48
## 6      -0.02       0.00     -234         48
## accel_dumbbell_z magnet_dumbbell_x magnet_dumbbell_y magnet_dumbbell_z
## 1      -271      -559       293        -65
## 2      -269      -555       296        -64
## 3      -270      -561       298        -63
## 4      -269      -552       303        -60
## 5      -270      -554       292        -68
## 6      -269      -558       294        -66
## roll_forearm pitch_forearm yaw_forearm kurtosis_roll_forearm
## 1      28.4     -63.9     -153
## 2      28.3     -63.9     -153
## 3      28.3     -63.9     -152
## 4      28.1     -63.9     -152
## 5      28.0     -63.9     -152
## 6      27.9     -63.9     -152
## kurtosis_pitch_forearm kurtosis_yaw_forearm skewness_roll_forearm
## 1
## 2

```

```

## 3
## 4
## 5
## 6
##   skewness_pitch_forearm skewness_yaw_forearm max_roll_forearm
## 1                               NA
## 2                               NA
## 3                               NA
## 4                               NA
## 5                               NA
## 6                               NA
##   max_pictch_forearm max_yaw_forearm min_roll_forearm min_pitch_forearm
## 1          NA           NA           NA           NA
## 2          NA           NA           NA           NA
## 3          NA           NA           NA           NA
## 4          NA           NA           NA           NA
## 5          NA           NA           NA           NA
## 6          NA           NA           NA           NA
##   min_yaw_forearm amplitude_roll_forearm amplitude_pitch_forearm
## 1                  NA           NA           NA
## 2                  NA           NA           NA
## 3                  NA           NA           NA
## 4                  NA           NA           NA
## 5                  NA           NA           NA
## 6                  NA           NA           NA
##   amplitude_yaw_forearm total_accel_forearm var_accel_forearm
## 1                  36           NA
## 2                  36           NA
## 3                  36           NA
## 4                  36           NA
## 5                  36           NA
## 6                  36           NA
##   avg_roll_forearm stddev_roll_forearm var_roll_forearm avg_pitch_forearm
## 1          NA           NA           NA           NA
## 2          NA           NA           NA           NA
## 3          NA           NA           NA           NA
## 4          NA           NA           NA           NA
## 5          NA           NA           NA           NA
## 6          NA           NA           NA           NA
##   stddev_pitch_forearm var_pitch_forearm avg_yaw_forearm
## 1          NA           NA           NA
## 2          NA           NA           NA
## 3          NA           NA           NA
## 4          NA           NA           NA
## 5          NA           NA           NA
## 6          NA           NA           NA
##   stddev_yaw_forearm var_yaw_forearm gyros_forearm_x gyros_forearm_y
## 1          NA           NA          0.03         0.00
## 2          NA           NA          0.02         0.00
## 3          NA           NA          0.03        -0.02

```

```

## 4          NA          NA       0.02      -0.02
## 5          NA          NA       0.02       0.00
## 6          NA          NA       0.02     -0.02
##   gyros_forearm_z accel_forearm_x accel_forearm_y accel_forearm_z
## 1      -0.02        192        203      -215
## 2      -0.02        192        203      -216
## 3       0.00        196        204      -213
## 4       0.00        189        206      -214
## 5      -0.02        189        206      -214
## 6      -0.03        193        203      -215
##   magnet_forearm_x magnet_forearm_y magnet_forearm_z classe
## 1      -17        654        476      A
## 2      -18        661        473      A
## 3      -18        658        469      A
## 4      -16        658        469      A
## 5      -17        655        473      A
## 6       -9        660        478      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)      :11007
##           kurtosis_pitch_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_pitch_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
## (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.  :-1.46000  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_pictch_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_pictch_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           Mean   :13.72
## 3rd Qu.: 99.55           3rd Qu.:19.00
## Max.   :273.59           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_pictch_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] "cvtd_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"
```

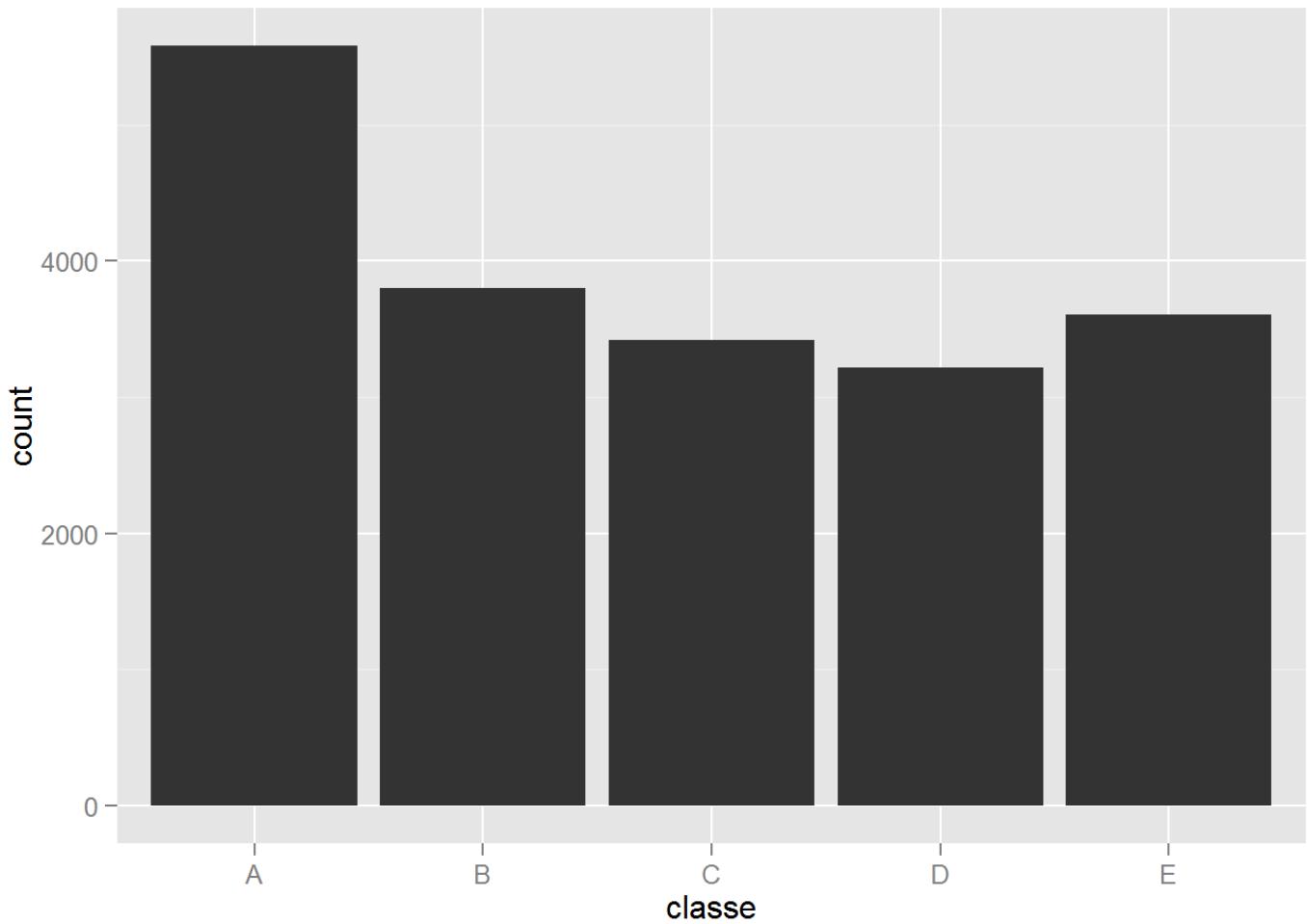
```

## [15] "skewness_roll_belt"      "skewness_roll_belt.1"
## [17] "skewness_yaw_belt"       "max_roll_belt"
## [19] "max_pictch_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_pictch_arm"
## [71] "kurtosis_yaw_arm"         "skewness_roll_arm"
## [73] "skewness_pitch_arm"        "skewness_yaw_arm"
## [75] "max_roll_arm"              "max_pictch_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_pictch_dumbbell"
## [89] "kurtosis_yaw_dumbbell"     "skewness_roll_dumbbell"
## [91] "skewness_pitch_dumbbell"    "skewness_yaw_dumbbell"
## [93] "max_roll_dumbbell"          "max_pictch_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"  
## [117] "accel_dumbbell_y"  
## [119] "magnet_dumbbell_x"  
## [121] "magnet_dumbbell_z"  
## [123] "pitch_forearm"  
## [125] "kurtosis_roll_forearm"  
## [127] "kurtosis_yaw_forearm"  
## [129] "skewness_pitch_forearm"  
## [131] "max_roll_forearm"  
## [133] "max_yaw_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"  
  
"accel_dumbbell_x"  
"accel_dumbbell_z"  
"magnet_dumbbell_y"  
"roll_forearm"  
"yaw_forearm"  
"kurtosis_pitch_forearm"  
"skewness_roll_forearm"  
"skewness_yaw_forearm"  
"max_pitch_forearm"  
"min_roll_forearm"  
"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
```

# Step 3 - 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(classe~, data=training, method="Lda")
#modelfitlda$results

# use rf
#modelfitrdf <- train(classe~, data=training, method="rf")
#modelfitrdf$results

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

```

## Confusion Matrix and Statistics
##
##             Reference
## Prediction    A     B     C     D     E
##           A 1267   372   376   352   134
##           B   21   320    28   151   130
##           C  104   257   451   301   251
##           D    0     0     0     0     0
##           E    3     0     0     0   386
##
## Overall Statistics
##
##                 Accuracy : 0.4943
##                 95% CI : (0.4802, 0.5084)
##      No Information Rate : 0.2845
##      P-Value [Acc > NIR] : < 2.2e-16
##
##                 Kappa : 0.34
## McNemar's Test P-Value : NA
##
## Statistics by Class:
##
##                                Class: A Class: B Class: C Class: D Class: E
## Sensitivity                  0.9082  0.33720  0.52749  0.0000  0.42841
## Specificity                  0.6483  0.91656  0.77451  1.0000  0.99925
## Pos Pred Value                0.5066  0.49231  0.33065       NaN  0.99229
## Neg Pred Value                0.9467  0.85214  0.88588  0.8361  0.88594
## Prevalence                     0.2845  0.19352  0.17435  0.1639  0.18373
## Detection Rate                 0.2584  0.06525  0.09197  0.0000  0.07871
## Detection Prevalence          0.5100  0.13254  0.27814  0.0000  0.07932
## Balanced Accuracy              0.7783  0.62688  0.65100  0.5000  0.71383

```

## Now calculating on test data

```

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

```

```

## [1] C A C A A C C A A A C C C A C A A A A C
## Levels: A B C D E

```