PML_Project

Starting with the analysis, we load de library we will need.

```
library(caret)
```

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

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

```
## Warning: package 'ggplot2' was built under R version 3.1.2
```

```
library(ggplot2)
library(rattle)
```

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

```
## Rattle: A free graphical interface for data mining with R.
## Versión 3.4.1 Copyright (c) 2006-2014 Togaware Pty Ltd.
## Escriba 'rattle()' para agitar, sacudir y  rotar sus datos.
```

Load de data en do a summary to understand the type of data. I fix the empty data to NA.

```
data <- read.csv("pml-training.CSV",na.strings=c("NA",""))
summary(data)
```

```
##        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    #DIV/0!  :   10
##  1st Qu.:  1.7600   1st Qu.: -88.30   1st Qu.: 3.00    -1.908453:    2
##  Median :  5.2800   Median : -13.00   Median :17.00    -0.016850:    1
##  Mean   :  0.3053   Mean   : -11.21   Mean   :11.31    -0.021024:    1
##  3rd Qu.: 14.9000   3rd Qu.:  12.90   3rd Qu.:18.00    -0.025513:    1
##  Max.   : 60.3000   Max.   : 179.00   Max.   :29.00    (Other)  :  391
##                                                        NA's     :19216
```

```
##  kurtosis_picth_belt kurtosis_yaw_belt skewness_roll_belt
##  #DIV/0!  :   32     #DIV/0!:  406     #DIV/0!  :    9
##  47.000000:    4     NA's   :19216     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
##  NA's     :19216                       NA's     :19216
##  skewness_roll_belt.1 skewness_yaw_belt max_roll_belt     max_picth_belt
##  #DIV/0!  :   32      #DIV/0!:  406     Min.   :-94.300   Min.   : 3.00
##  0.000000 :    4      NA's   :19216     1st Qu.:-88.000   1st Qu.: 5.00
##  -2.156553:    3                        Median : -5.100   Median :18.00
##  -3.072669:    3                        Mean   : -6.667   Mean   :12.92
##  -6.324555:    3                        3rd Qu.: 18.500   3rd Qu.:19.00
##  (Other)  :  361                        Max.   :180.000   Max.   :30.00
##  NA's     :19216                        NA's   :19216     NA's   :19216
##   max_yaw_belt   min_roll_belt     min_pitch_belt   min_yaw_belt
##  -1.1   :   30   Min.   :-180.00   Min.   : 0.00   -1.1   :   30
##  -1.4   :   29   1st Qu.: -88.40   1st Qu.: 3.00   -1.4   :   29
##  -1.2   :   26   Median :  -7.85   Median :16.00   -1.2   :   26
##  -0.9   :   24   Mean   : -10.44   Mean   :10.76   -0.9   :   24
##  -1.3   :   22   3rd Qu.:   9.05   3rd Qu.:17.00   -1.3   :   22
##  (Other):  275   Max.   : 173.00   Max.   :23.00   (Other):  275
##  NA's   :19216   NA's   :19216     NA's   :19216   NA's   :19216
##  amplitude_roll_belt amplitude_pitch_belt amplitude_yaw_belt
##  Min.   :  0.000     Min.   : 0.000       #DIV/0!:   10
##  1st Qu.:  0.300     1st Qu.: 1.000       0.00   :   12
##  Median :  1.000     Median : 1.000       0.0000 :  384
##  Mean   :  3.769     Mean   : 2.167       NA's   :19216
##  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_picth_arm kurtosis_yaw_arm skewness_roll_arm
##  #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
##  NA's    :19216    NA's    :19216     NA's    :19216   NA's    :19216
##  skewness_pitch_arm skewness_yaw_arm  max_roll_arm     max_picth_arm
##  #DIV/0! :   80     #DIV/0! :   11   Min.   :-73.100   Min.   :-173.000
##  -0.00184:    1     -1.62032:    2   1st Qu.: -0.175   1st Qu.:  -1.975
##  -0.01185:    1     0.55053 :    2   Median :  4.950   Median :  23.250
##  -0.01247:    1     -0.00311:    1   Mean   : 11.236   Mean   :  35.751
##  -0.02063:    1     -0.00562:    1   3rd Qu.: 26.775   3rd Qu.:  95.975
##  (Other) :  322     (Other) :  389   Max.   : 85.500   Max.   : 180.000
##  NA's    :19216     NA's    :19216   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_picth_dumbbell kurtosis_yaw_dumbbell
##  #DIV/0!:    5          -0.5464:    2           #DIV/0!:  406
```

```
##  -0.2583:    2          -0.9334:    2          NA's   :19216
##  -0.3705:    2          -2.0833:    2
##  -0.5855:    2          -2.0851:    2
##  -2.0851:    2          -2.0889:    2
##  (Other):  393          (Other):  396
##  NA's   :19216          NA's   :19216
##  skewness_roll_dumbbell skewness_pitch_dumbbell skewness_yaw_dumbbell
##  #DIV/0!:    4          -0.2328:    2          #DIV/0!:  406
##  -0.9324:    2          -0.3521:    2          NA's   :19216
##  0.1110 :    2          -0.7036:    2
##  1.0312 :    2          0.1090 :    2
##  -0.0082:    1          1.0326 :    2
##  (Other):  395          (Other):  396
##  NA's   :19216          NA's   :19216
##  max_roll_dumbbell max_picth_dumbbell max_yaw_dumbbell min_roll_dumbbell
##  Min.   :-70.10    Min.   :-112.90    -0.6   :   20    Min.   :-149.60
##  1st Qu.:-27.15    1st Qu.: -66.70    0.2    :   19    1st Qu.: -59.67
##  Median : 14.85    Median :  40.05    -0.8   :   18    Median : -43.55
##  Mean   : 13.76    Mean   :  32.75    -0.3   :   16    Mean   : -41.24
##  3rd Qu.: 50.58    3rd Qu.: 133.22    -0.2   :   15    3rd Qu.: -25.20
##  Max.   :137.00    Max.   : 155.00    (Other):  318    Max.   :  73.20
##  NA's   :19216     NA's   :19216      NA's   :19216    NA's   :19216
##  min_pitch_dumbbell min_yaw_dumbbell amplitude_roll_dumbbell
##  Min.   :-147.00    -0.6   :   20    Min.   :  0.00
##  1st Qu.: -91.80    0.2    :   19    1st Qu.: 14.97
##  Median : -66.15    -0.8   :   18    Median : 35.05
##  Mean   : -33.18    -0.3   :   16    Mean   : 55.00
##  3rd Qu.:  21.20    -0.2   :   15    3rd Qu.: 81.04
##  Max.   : 120.90    (Other):  318    Max.   :256.48
##  NA's   :19216      NA's   :19216    NA's   :19216
##  amplitude_pitch_dumbbell amplitude_yaw_dumbbell total_accel_dumbbell
##  Min.   :  0.00           #DIV/0!:    5          Min.   : 0.00
##  1st Qu.: 17.06           0.00   :  401          1st Qu.: 4.00
##  Median : 41.73           NA's   :19216          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
```

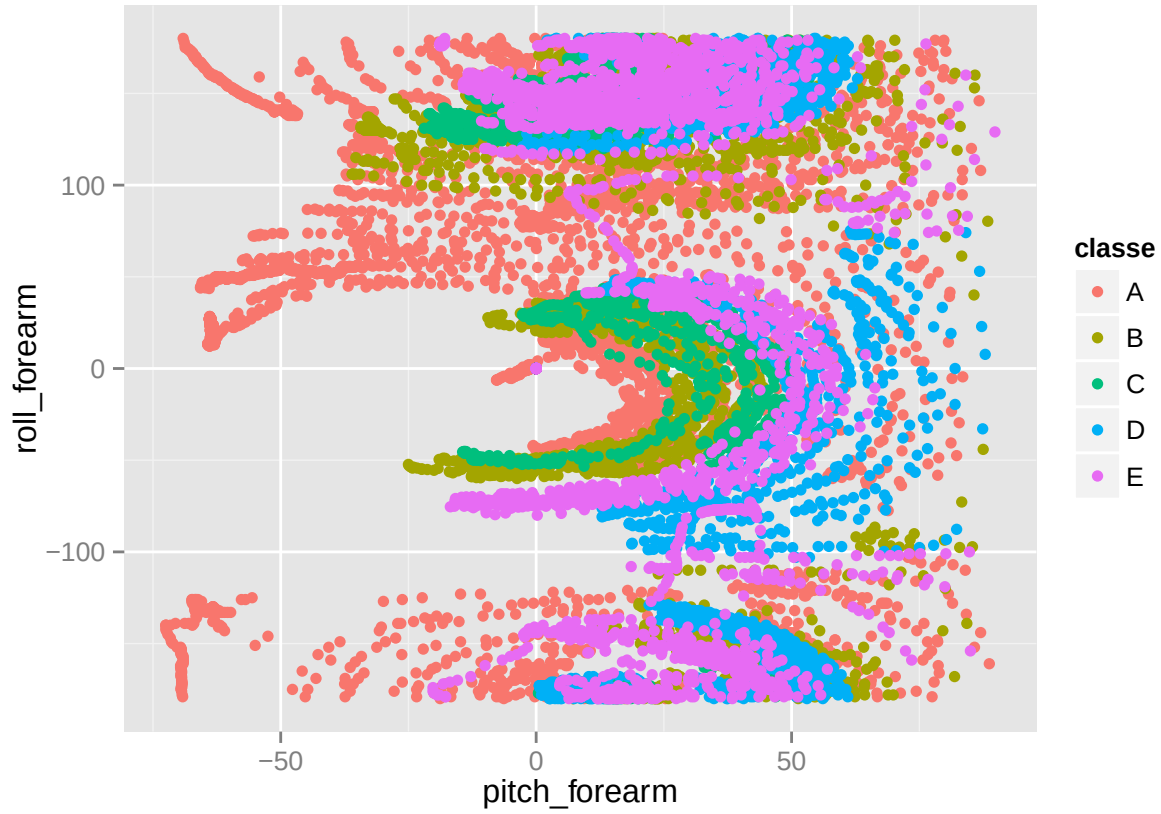
```
##  var_pitch_dumbbell avg_yaw_dumbbell   stddev_yaw_dumbbell
##  Min.   :   0.00    Min.   :-117.950   Min.   :  0.000
##  1st Qu.:  12.12    1st Qu.: -76.696   1st Qu.:  3.885
##  Median :  65.44    Median :  -4.505   Median : 10.264
##  Mean   : 350.31    Mean   :   0.202   Mean   : 16.647
##  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   #DIV/0!:   84
##  1st Qu.:  0.00   1st Qu.: -68.60   -0.8079:    2
##  Median :  9.24   Median :   0.00   -0.9169:    2
##  Mean   : 10.71   Mean   :  19.21   -0.0227:    1
##  3rd Qu.: 28.40   3rd Qu.: 110.00   -0.0359:    1
##  Max.   : 89.80   Max.   : 180.00   (Other):  316
##                                     NA's   :19216
##  kurtosis_picth_forearm kurtosis_yaw_forearm skewness_roll_forearm
##  #DIV/0!:   85          #DIV/0!:  406        #DIV/0!:   83
##  -0.0073:    1          NA's   :19216        -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
##  NA's   :19216                               NA's   :19216
##  skewness_pitch_forearm skewness_yaw_forearm max_roll_forearm
##  #DIV/0!:   85          #DIV/0!:  406        Min.   :-66.60
##  0.0000 :    4          NA's   :19216        1st Qu.:  0.00
##  -0.6992:    2                               Median : 26.80
##  -0.0113:    1                               Mean   : 24.49
##  -0.0131:    1                               3rd Qu.: 45.95
```

```
##  (Other):  313                                 Max.   : 89.80
##  NA's   :19216                                 NA's   :19216
##  max_picth_forearm max_yaw_forearm min_roll_forearm  min_pitch_forearm
##  Min.   :-151.00   #DIV/0!:   84   Min.   :-72.500   Min.   :-180.00
##  1st Qu.:   0.00   -1.2   :   32   1st Qu.: -6.075   1st Qu.:-175.00
##  Median : 113.00   -1.3   :   31   Median :  0.000   Median : -61.00
##  Mean   :  81.49   -1.4   :   24   Mean   : -0.167   Mean   : -57.57
##  3rd Qu.: 174.75   -1.5   :   24   3rd Qu.: 12.075   3rd Qu.:   0.00
##  Max.   : 180.00   (Other):  211   Max.   : 62.100   Max.   : 167.00
##  NA's   :19216     NA's   :19216   NA's   :19216     NA's   :19216
##  min_yaw_forearm amplitude_roll_forearm amplitude_pitch_forearm
##  #DIV/0!:   84   Min.   :  0.000        Min.   :  0.0
##  -1.2   :   32   1st Qu.:  1.125        1st Qu.:  2.0
##  -1.3   :   31   Median : 17.770        Median : 83.7
##  -1.4   :   24   Mean   : 24.653        Mean   :139.1
##  -1.5   :   24   3rd Qu.: 39.875        3rd Qu.:350.0
##  (Other):  211   Max.   :126.000        Max.   :360.0
##  NA's   :19216   NA's   :19216          NA's   :19216
##  amplitude_yaw_forearm total_accel_forearm var_accel_forearm
##  #DIV/0!:   84         Min.   :  0.00      Min.   :  0.000
##  0.00   :  322         1st Qu.: 29.00      1st Qu.:  6.759
##  NA's   :19216         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
```

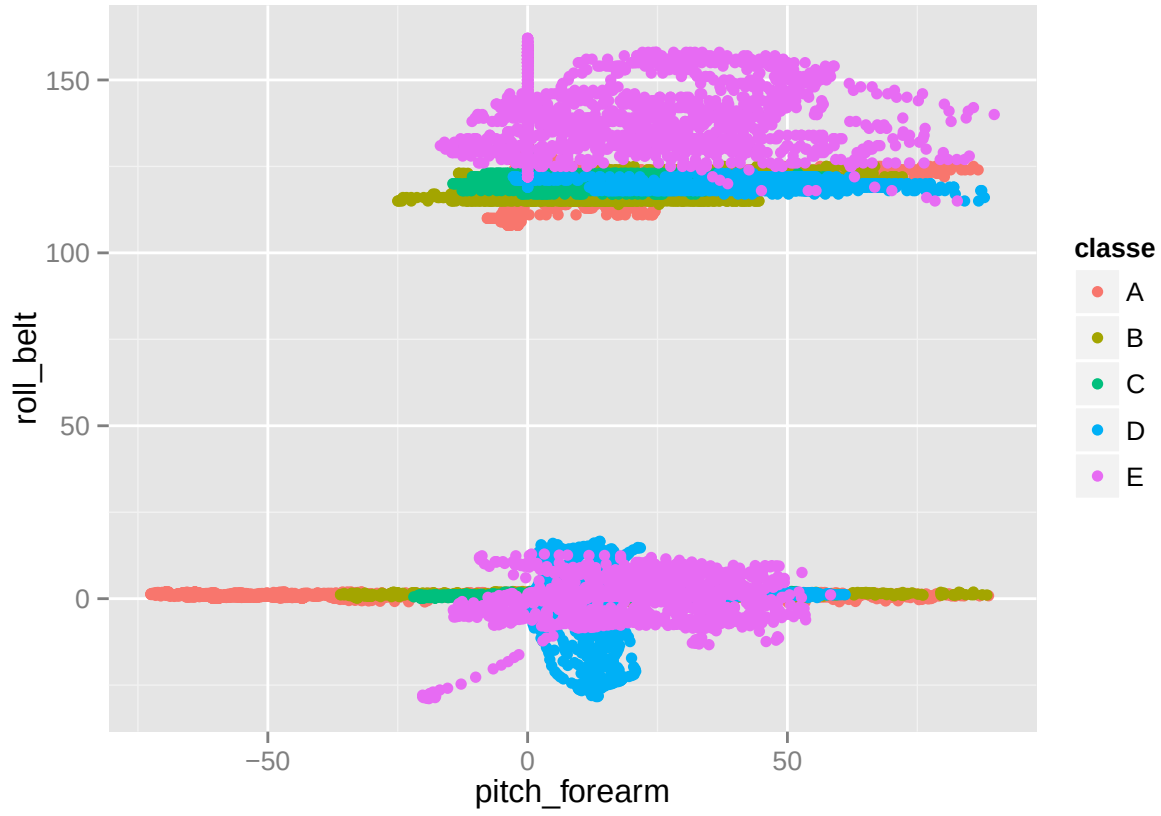
```
##  Mean   :  0.07517   Mean   :  0.1512   Mean   : -61.65   Mean   : 163.7
##  3rd Qu.:  1.62000   3rd Qu.:  0.4900   3rd Qu.:  76.00   3rd Qu.: 312.0
##  Max.   :311.00000   Max.   :231.0000   Max.   : 477.00   Max.   : 923.0
##
##  accel_forearm_z   magnet_forearm_x  magnet_forearm_y magnet_forearm_z
##  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
##
##
```

We make some graphics to find the relations.

```
qplot(pitch_forearm,roll_forearm,data=data,colour=classe)
```



```
qplot(pitch_forearm,roll_belt,data=data,colour=classe)
```



Indentify the variables wich I won't use, the firt 7 variables and the variables with NA.

```
col <- c("X","user_name","cvtd_timestamp","raw_timestamp_part_1","raw_timestamp_part_2","new_window","nu


for(i in 1:dim(data)[2]){
  if(sum(is.na(data[,i])) > 0){
    col <- c(col,names(data[i]))
  }
}

datacln <- data[,!(names(data) %in% col)]
```

Split the data in training and testing, using the createFolds function I generated 3 sets of traning-testing.

```
inTrain <- createDataPartition(y=datacln$classe, p=0.6,list=FALSE)

set.seed(200)
trfs <- createFolds(y=datacln$classe,k=3,list=TRUE,returnTrain=TRUE)

training1 <- datacln[trfs[[1]],]
training2 <- datacln[trfs[[2]],]
training3 <- datacln[trfs[[3]],]
```

```
testing1 <- datacln[-trfs[[1]],]
testing2 <- datacln[-trfs[[2]],]
testing3 <- datacln[-trfs[[3]],]
```

The first model is simple with rpart method.

```
set.seed(300)
fit1 <- train(classe~.,method="rpart", data=training1)
```

```
## Loading required package: rpart
```

```
predict1 <- predict(fit1, newdata=testing1)
confusionMatrix(predict1,testing1$classe)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1701  535  531  486  177
##          B   21  429   46  198  169
##          C  132  301  564  388  303
##          D    0    0    0    0    0
##          E    6    0    0    0  553
##
## Overall Statistics
##
##                Accuracy : 0.4965
##                  95% CI : (0.4843, 0.5087)
##     No Information Rate : 0.2844
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.3414
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            0.9145   0.3391  0.49430   0.0000  0.46007
## Specificity            0.6306   0.9177  0.79181   1.0000  0.99888
## Pos Pred Value         0.4959   0.4971  0.33412      NaN  0.98927
## Neg Pred Value         0.9489   0.8527  0.88108   0.8361  0.89149
## Prevalence             0.2844   0.1934  0.17446   0.1639  0.18379
## Detection Rate         0.2601   0.0656  0.08624   0.0000  0.08456
## Detection Prevalence   0.5245   0.1320  0.25810   0.0000  0.08547
## Balanced Accuracy      0.7725   0.6284  0.64306   0.5000  0.72947
```

I create another model rpart with a cross valitation train control.

```
set.seed(300)
fit2 <- train(classe~.,method="rpart", data=training2,trControl=trainControl(method="cv",number=4))
predict2 <- predict(fit2, newdata=testing2)
confusionMatrix(predict2,testing2$classe)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1688  543  515  483  170
##          B   37  399   32  181  165
##          C  132  324  594  408  343
##          D    0    0    0    0    0
##          E    3    0    0    0  524
##
## Overall Statistics
##
##                Accuracy : 0.49
##                  95% CI : (0.4778, 0.5022)
##     No Information Rate : 0.2844
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.3336
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            0.9075   0.3152  0.52060   0.0000  0.43594
## Specificity            0.6345   0.9213  0.77648   1.0000  0.99944
## Pos Pred Value         0.4966   0.4902  0.32982      NaN  0.99431
## Neg Pred Value         0.9453   0.8486  0.88460   0.8361  0.88726
## Prevalence             0.2844   0.1935  0.17444   0.1639  0.18376
## Detection Rate         0.2581   0.0610  0.09081   0.0000  0.08011
## Detection Prevalence   0.5196   0.1244  0.27534   0.0000  0.08057
## Balanced Accuracy      0.7710   0.6182  0.64854   0.5000  0.71769
```

Finally, another model with rando forest.

```
set.seed(300)
fit3 <- train(classe~.,method="rf", data=training3,trControl=trainControl(method="cv",number=4), preProc
```

```
## 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.
```

```
predict3 <- predict(fit3, newdata=testing3)
confusionMatrix(predict3,testing3$classe)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1853    4    0    0    0
```

```
##          B    7 1261    7    0    0
##          C    0    1 1131   15    0
##          D    0    0    2 1057    3
##          E    0    0    0    0 1200
##
## Overall Statistics
##
##                Accuracy : 0.994
##                  95% CI : (0.9919, 0.9958)
##     No Information Rate : 0.2844
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9925
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            0.9962   0.9961   0.9921   0.9860   0.9975
## Specificity            0.9991   0.9973   0.9970   0.9991   1.0000
## Pos Pred Value         0.9978   0.9890   0.9861   0.9953   1.0000
## Neg Pred Value         0.9985   0.9991   0.9983   0.9973   0.9994
## Prevalence             0.2844   0.1935   0.1743   0.1639   0.1839
## Detection Rate         0.2833   0.1928   0.1729   0.1616   0.1835
## Detection Prevalence   0.2839   0.1949   0.1754   0.1624   0.1835
## Balanced Accuracy      0.9977   0.9967   0.9946   0.9925   0.9988
```

The randon forest is way better than the others according to the accuracy, is the final model.

Test the model in the test data.

```
pmltest <- read.csv("pml-testing.CSV",na.strings=c("NA",""))
predict_test <- predict(fit3, newdata=pmltest)
predict_test
```

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