**WLE\_classification.R, Feature selections**

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1. Use the below given data set DataSet
2. Perform the below given activities:
3. Create classification model using different classifiers
4. Verify model goodness of fit
5. Apply all the model validation techniques.

The *Weight Lifting Exercises (WLE)* dataset is used to investigate *how well* an activity is being performed. Six participants were performing one set of 10 repetitions of the *Unilateral Dumbbell Biceps Curl* in *five* different fashions:

* + Class A - exactly according to the specification,
  + Class B - throwing the elbows to the front,
  + Class C - lifting the dumbbell only halfway,  Class D - lowering the dumbbell only halfway,  Class E - throwing the hips to the front.

*Class A* corresponds to the specified execution of the exercise, while the other 4 classes correspond to common mistakes

The outcome of the given classification problem is given by the variable classe in the last column which is a factor variable with 5 levels “A”,“B”,“C”,“D”, and “E”. Each class is sufficiently represented in the training dataset. The outcome variable classe, however, is not included in the test dataset where it is replaced by a variable problem\_id for identification purposes of the 20 test cases for the submission of the prediction results. Both datasets are consistent in their variable names (except for the last column with the outcome classe in the training dataset and problem\_id in test dataset) and contain a considerable number of *missing values* marked as NA.

For feature extraction we only use the variables which are related to the raw measurements from the sensors located on the belt, forearm, arm, and dumbbell for the physical movement during the exercise.

A quick verification shows that the reduced training (trainPredSet) and test (testPredSet) datasets are consistent in their predictor variable names and have no missing values (NAs).

In order to evaluate our prediction algorithm cross-validation is used. The training set is split into a cross-validation training set cvTrain (80%) and test set cvTest (20%). So we can train our model on the cvTrain dataset and test the accuracy of our prediction on the cvTest dataset in order to evaluate the influence of different training methods, predictor selections and predictor preprocessing methods. A high number of training examples (80%) is chosen to optimize for the training of the model.

When using the described prediction model to predict the 20 different test cases from the original test dataset testing we obtain 20 predictions as output .

|  |  |
| --- | --- |
| **setwd**("C:/Users/Khushboo/Desktop")  WLE<- **read.csv**("WLE.csv",header=T, na.strings=**c**("","NA")) data<-WLE **View**(data) **summary**(data) **summary**(data**$**classe) **names**(data)  **library**(devtools) **install\_github**('adam-m-mcelhinney/helpRFunctions') **library**(helpRFunctions)  training<-data[1**:**4000,] testing<-data[4001**:**4024,] **dim**(training) **summary**(training) **str**(training)  predictorIdx <- **c**(**grep**("^accel", **names**(training)), **grep**("^gyros", **names**( train ing)),  **grep**("^magnet", **names**(training)), **grep**("^roll", **names**( train ing)), **grep**("^pitch", **names**(training)), **grep**("^yaw", **names**(training)), **grep**( "^total", **names**(training)))    trainPredSet <- training[, **c**(predictorIdx, 157)]    testPredSet <- testing[, **c**(predictorIdx, 157)] **length**(predictorIdx) **sum**(**names**(testing)[predictorIdx] **!=** **names**(training)[predictorIdx])  *#sum(is.na(trainPredSet)) color = trainPredSet$classe)* **nearZeroVar**(trainPredSet[, **-**7], saveMetric = TRUE)  **qplot**(x = trainPredSet[, "accel\_belt\_x"], y = trainPredSet[, "accel\_arm\_x"],c olor = trainPredSet**$**classe)    **set.seed**(125)  inTrain <- **createDataPartition**(y = trainPredSet**$**classe, p = 0.8, list = FALSE | |
| ) | cvTrain <- trainPredSet[inTrain, ] cvTest <- trainPredSet[**-**inTrain, ]  fitCtrl <- **trainControl**(method = "repeatedcv", number = 10, repeats = 10) **set.seed**(125)  modFit <- **train**(classe **~** ., data = cvTrain, method = "qda", preProcess = **c**("c enter","scale"), trControl = fitCtrl)  **print**(modFit)  ptrain <- **predict**(modFit, newdata = cvTrain) equalPredTrain <- (ptrain **==** cvTrain**$**classe) **print**(**sum**(equalPredTrain)**/length**(equalPredTrain)) **confusionMatrix**(data = ptrain, reference = cvTrain**$**classe)  ptest <- **predict**(modFit, newdata = cvTest) equalPredTest <- (ptest **==** cvTest**$**classe) **print**(**sum**(equalPredTest)**/length**(equalPredTest))  testPrediction <- **predict**(modFit, newdata = testing) **print**(**rbind**(testing[1**:**20, 157], **as.character**(testPrediction))) |
|  |

|  |  |
| --- | --- |
| **setwd**("C:/Users/Khushboo/Desktop”) |  |
| WLE<- **read.csv**("WLE.csv",header=T, na.strings=**c**("","NA")) data<-WLE **View**(data) **summary**(data)  ## user\_name raw\_timestamp\_part\_1 raw\_timestamp\_part\_2  ## adelmo : 311 Min. :1.322e+09 Min. : 297  ## carlitos:1580 1st Qu.:1.323e+09 1st Qu.:244321  ## eurico : 88 Median :1.323e+09 Median :492342  ## jeremy : 4 Mean :1.323e+09 Mean :490377  ## pedro :2041 3rd Qu.:1.323e+09 3rd Qu.:736278  ## Max. :1.323e+09 Max. :996453  ##  ## cvtd\_timestamp new\_window num\_window roll\_belt  ## 2/12/2011 13:35 : 311 no :3936 Min. : 1.00 Min. :-28.90  ## 28/11/2011 14:15: 88 yes: 88 1st Qu.:24.00 1st Qu.: 1.38  ## 30/11/2011 17:12: 4 Median :46.00 Median :122.00  ## 5/12/2011 11:23 : 337 Mean :46.33 Mean : 73.31  ## 5/12/2011 11:25 :1243 3rd Qu.:69.00 3rd Qu.:124.00  ## 5/12/2011 14:22 : 456 Max. :91.00 Max. :159.00  ## 5/12/2011 14:23 :1585  ## pitch\_belt yaw\_belt total\_accel\_belt kurtosis\_roll\_belt  ## Min. :-56.20 Min. :-179.000 Min. : 0.00 Min. :-3.333  ## 1st Qu.: 6.22 1st Qu.: -93.100 1st Qu.: 3.00 1st Qu.:-1.036  ## Median : 25.50 Median : -4.940 Median :19.00 Median :-1.036  ## Mean : 14.16 Mean : -30.975 Mean :12.77 Mean :-1.027  ## 3rd Qu.: 26.40 3rd Qu.: -2.695 3rd Qu.:20.00 3rd Qu.:-1.036  ## Max. : 60.30 Max. : 179.000 Max. :26.00 Max. : 7.515  ##  ## kurtosis\_picth\_belt skewness\_roll\_belt skewness\_roll\_belt.1  ## Min. :-2.1212 Min. :-3.031527 Min. :-6.63325  ## 1st Qu.:-0.3913 1st Qu.: 0.005406 1st Qu.: 0.04512  ## Median :-0.3913 Median : 0.005406 Median : 0.04512  ## Mean :-0.3496 Mean : 0.003858 Mean : 0.04011  ## 3rd Qu.:-0.3913 3rd Qu.: 0.005406 3rd Qu.: 0.04512  ## Max. :54.0000 Max. : 2.713152 Max. : 7.34847  ##  ## max\_roll\_belt max\_picth\_belt max\_yaw\_belt min\_roll\_belt  ## Min. :-94.400 Min. : 3.00 Min. :-3.3000 Min. :-179.000  ## 1st Qu.: -4.100 1st Qu.:20.00 1st Qu.:-1.0000 1st Qu.: -7.250  ## Median : -4.100 Median :20.00 Median :-1.0000 Median : -7.250 |

## Mean : -4.626 Mean :19.87 Mean :-0.9917 Mean : -7.838

## 3rd Qu.: -4.100 3rd Qu.:20.00 3rd Qu.:-1.0000 3rd Qu.: -7.250

## Max. :179.000 Max. :26.00 Max. : 7.5000 Max. : 157.000 ##

## min\_pitch\_belt min\_yaw\_belt amplitude\_roll\_belt

## Min. : 0.00 Min. :-3.3000 Min. : 0.000

## 1st Qu.:18.00 1st Qu.:-1.0000 1st Qu.: 1.345

## Median :18.00 Median :-1.0000 Median : 1.345

## Mean :17.86 Mean :-0.9917 Mean : 1.446

## 3rd Qu.:18.00 3rd Qu.:-1.0000 3rd Qu.: 1.345

## Max. :20.00 Max. : 7.5000 Max. :358.000

##

## amplitude\_pitch\_belt amplitude\_yaw\_belt var\_total\_accel\_belt

## Min. : 0.000 Min. :0 Min. : 0.0000

## 1st Qu.: 2.000 1st Qu.:0 1st Qu.: 0.3000

## Median : 2.000 Median :0 Median : 0.3000

## Mean : 2.014 Mean :0 Mean : 0.3148

## 3rd Qu.: 2.000 3rd Qu.:0 3rd Qu.: 0.3000

## Max. :21.000 Max. :0 Max. :18.2000

##

## avg\_roll\_belt stddev\_roll\_belt var\_roll\_belt avg\_pitch\_belt

## Min. :-27.4 Min. :0.0000 Min. : 0.0000 Min. :-49.40

## 1st Qu.:121.9 1st Qu.:0.6000 1st Qu.: 0.3500 1st Qu.: 25.75

## Median :121.9 Median :0.6000 Median : 0.3500 Median : 25.75

## Mean :120.8 Mean :0.6257 Mean : 0.5371 Mean : 25.49

## 3rd Qu.:121.9 3rd Qu.:0.6000 3rd Qu.: 0.3500 3rd Qu.: 25.75

## Max. :154.5 Max. :8.5000 Max. :71.8000 Max. : 59.70

##

## stddev\_pitch\_belt var\_pitch\_belt avg\_yaw\_belt stddev\_yaw\_belt

## Min. :0.0000 Min. : 0.0000 Min. :-94.400 Min. : 0.0000

## 1st Qu.:0.3500 1st Qu.: 0.1000 1st Qu.: -4.950 1st Qu.: 0.4000

## Median :0.3500 Median : 0.1000 Median : -4.950 Median : 0.4000

## Mean :0.3573 Mean : 0.1288 Mean : -5.515 Mean : 0.4449

## 3rd Qu.:0.3500 3rd Qu.: 0.1000 3rd Qu.: -4.950 3rd Qu.: 0.4000

## Max. :6.2000 Max. :39.0000 Max. :158.600 Max. :163.1000

##

## var\_yaw\_belt gyros\_belt\_x gyros\_belt\_y

## Min. : 0.000 Min. :-0.7900 Min. :-0.470000

## 1st Qu.: 0.170 1st Qu.:-0.4300 1st Qu.:-0.030000

## Median : 0.170 Median :-0.2400 Median :-0.020000

## Mean : 6.796 Mean :-0.1823 Mean :-0.008837

## 3rd Qu.: 0.170 3rd Qu.: 0.0200 3rd Qu.: 0.000000

## Max. :26610.320 Max. : 2.0200 Max. : 0.420000

##

## gyros\_belt\_z accel\_belt\_x accel\_belt\_y accel\_belt\_z

## Min. :-0.7700 Min. :-120.00 Min. :-71.00 Min. :-244.00

## 1st Qu.:-0.4600 1st Qu.: -42.00 1st Qu.: 4.00 1st Qu.:-176.00

## Median :-0.4100 Median : -34.00 Median : 65.00 Median :-166.00

## Mean :-0.2464 Mean : -24.36 Mean : 39.84 Mean : -94.73

## 3rd Qu.:-0.0200 3rd Qu.: -16.00 3rd Qu.: 70.00 3rd Qu.: 20.00 ## Max. : 0.8200 Max. : 80.00 Max. :164.00 Max. : 77.00

## ## magnet\_belt\_x magnet\_belt\_y magnet\_belt\_z roll\_arm

## Min. :-30.00 Min. :428.0 Min. :-513.0 Min. :-180.00

## 1st Qu.: -3.00 1st Qu.:577.0 1st Qu.:-379.0 1st Qu.: -34.40

## Median : 2.00 Median :585.0 Median :-366.0 Median : 72.10

## Mean : 24.65 Mean :582.7 Mean :-340.9 Mean : 40.01

## 3rd Qu.: 8.00 3rd Qu.:601.0 3rd Qu.:-311.0 3rd Qu.: 124.00

## Max. :485.00 Max. :652.0 Max. : 293.0 Max. : 180.00

##

## pitch\_arm yaw\_arm total\_accel\_arm var\_accel\_arm

## Min. :-87.100 Min. :-180.000 Min. : 1.00 Min. : 0.00

## 1st Qu.:-32.200 1st Qu.: -59.675 1st Qu.:15.00 1st Qu.: 65.10

## Median : -8.645 Median : 17.500 Median :25.00 Median : 65.10

## Mean :-10.539 Mean : 2.768 Mean :24.89 Mean : 65.28

## 3rd Qu.: 14.600 3rd Qu.: 72.825 3rd Qu.:34.00 3rd Qu.: 65.10

## Max. : 81.400 Max. : 180.000 Max. :59.00 Max. :253.01

##

## avg\_roll\_arm stddev\_roll\_arm var\_roll\_arm avg\_pitch\_arm

## Min. :-169.69 Min. : 0.00 Min. : 0.0 Min. :-57.29

## 1st Qu.: 76.22 1st Qu.: 16.10 1st Qu.: 259.4 1st Qu.:-10.17

## Median : 76.22 Median : 16.10 Median : 259.4 Median :-10.17

## Mean : 75.37 Mean : 16.23 Mean : 283.6 Mean :-10.15

## 3rd Qu.: 76.22 3rd Qu.: 16.10 3rd Qu.: 259.4 3rd Qu.:-10.17

## Max. : 160.78 Max. :161.96 Max. :26232.2 Max. : 54.60

##

## stddev\_pitch\_arm var\_pitch\_arm avg\_yaw\_arm stddev\_yaw\_arm

## Min. : 0.00 Min. : 0.0 Min. :-164.64 Min. : 0.00

## 1st Qu.:10.67 1st Qu.:113.8 1st Qu.: 19.06 1st Qu.: 35.88

## Median :10.67 Median :113.8 Median : 19.06 Median : 35.88

## Mean :10.70 Mean :116.1 Mean : 18.70 Mean : 35.90

## 3rd Qu.:10.67 3rd Qu.:113.8 3rd Qu.: 19.06 3rd Qu.: 35.88

## Max. :30.78 Max. :947.3 Max. : 148.45 Max. :177.04

##

## var\_yaw\_arm gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z

## Min. : 0 Min. :-5.2000 Min. :-3.4400 Min. :-2.17000

## 1st Qu.: 1287 1st Qu.:-2.0925 1st Qu.:-0.9200 1st Qu.:-0.20000

## Median : 1287 Median :-0.0200 Median :-0.0300 Median : 0.00000

## Mean : 1307 Mean :-0.1852 Mean :-0.1818 Mean : 0.04444

## 3rd Qu.: 1287 3rd Qu.: 1.7000 3rd Qu.: 0.5800 3rd Qu.: 0.28000

## Max. :31345 Max. : 4.3400 Max. : 2.4600 Max. : 3.02000

##

## accel\_arm\_x accel\_arm\_y accel\_arm\_z magnet\_arm\_x

## Min. :-346.00 Min. :-252.00 Min. :-538.00 Min. :-515.0

## 1st Qu.: -88.00 1st Qu.: -21.00 1st Qu.:-124.00 1st Qu.:-332.0

## Median : 24.00 Median : 22.00 Median : 6.00 Median : 278.5

## Mean : 34.38 Mean : 26.87 Mean : -41.39 Mean : 194.3

## 3rd Qu.: 136.00 3rd Qu.: 96.25 3rd Qu.: 76.00 3rd Qu.: 651.0

## Max. : 434.00 Max. : 229.00 Max. : 209.00 Max. : 782.0

## ## magnet\_arm\_y magnet\_arm\_z kurtosis\_roll\_arm kurtosis\_picth\_arm

## Min. :-392.0 Min. :-573.0 Min. :-3.333 Min. :-2.0835

## 1st Qu.: -13.0 1st Qu.: -1.0 1st Qu.:-1.182 1st Qu.:-0.9691

## Median : 267.0 Median : 431.0 Median :-1.182 Median :-0.9691

## Mean : 161.7 Mean : 253.2 Mean :-1.172 Mean :-0.9507

## 3rd Qu.: 348.0 3rd Qu.: 515.0 3rd Qu.:-1.182 3rd Qu.:-0.9691

## Max. : 482.0 Max. : 647.0 Max. :18.719 Max. :23.8408

##

## kurtosis\_yaw\_arm skewness\_roll\_arm skewness\_pitch\_arm skewness\_yaw\_arm

## Min. :-1.6308 Min. :-1.7457 Min. :-4.9942 Min. :-6.00000

## 1st Qu.:-0.8698 1st Qu.: 0.1235 1st Qu.:-0.1032 1st Qu.: 0.05976

## Median :-0.8698 Median : 0.1235 Median :-0.1032 Median : 0.05976

## Mean :-0.8481 Mean : 0.1246 Mean :-0.1058 Mean : 0.05742

## 3rd Qu.:-0.8698 3rd Qu.: 0.1235 3rd Qu.:-0.1032 3rd Qu.: 0.05976

## Max. :36.0000 Max. : 4.3945 Max. : 2.1711 Max. : 2.10699

##

## max\_roll\_arm max\_picth\_arm max\_yaw\_arm min\_roll\_arm

## Min. :-36.300 Min. :-164.00 Min. : 3 Min. :-87.10

## 1st Qu.: 8.450 1st Qu.: 77.25 1st Qu.:38 1st Qu.:-33.60

## Median : 8.450 Median : 77.25 Median :38 Median :-33.60

## Mean : 8.478 Mean : 76.79 Mean :38 Mean :-33.47

## 3rd Qu.: 8.450 3rd Qu.: 77.25 3rd Qu.:38 3rd Qu.:-33.60

## Max. : 81.400 Max. : 180.00 Max. :59 Max. : 35.70

##

## min\_pitch\_arm min\_yaw\_arm amplitude\_roll\_arm amplitude\_pitch\_arm

## Min. :-180.00 Min. : 1.00 Min. : 0.00 Min. : 0.0

## 1st Qu.: -58.60 1st Qu.:10.00 1st Qu.:36.95 1st Qu.:121.5

## Median : -58.60 Median :10.00 Median :36.95 Median :121.5

## Mean : -58.53 Mean :10.06 Mean :36.96 Mean :121.3

## 3rd Qu.: -58.60 3rd Qu.:10.00 3rd Qu.:36.95 3rd Qu.:121.5

## Max. : 146.00 Max. :34.00 Max. :90.00 Max. :360.0

##

## amplitude\_yaw\_arm roll\_dumbbell pitch\_dumbbell yaw\_dumbbell

## Min. : 0.00 Min. :-152.782 Min. :-134.73 Min. :-129.33

## 1st Qu.:27.00 1st Qu.: -34.657 1st Qu.: -12.93 1st Qu.: 21.35

## Median :27.00 Median : -2.295 Median : 14.48 Median : 72.49

## Mean :26.96 Mean : 3.500 Mean : 5.18 Mean : 55.66

## 3rd Qu.:27.00 3rd Qu.: 58.014 3rd Qu.: 27.95 3rd Qu.: 122.01

## Max. :52.00 Max. : 139.729 Max. : 97.28 Max. : 152.92

## ## kurtosis\_roll\_dumbbell kurtosis\_picth\_dumbbell kurtosis\_yaw\_dumbbell

## Min. :-2.08890 Min. :-2.0889 Mode:logical

## 1st Qu.:-0.09595 1st Qu.:-0.4422 NA's:4024

## Median :-0.09595 Median :-0.4422

## Mean :-0.08668 Mean :-0.4313

## 3rd Qu.:-0.09595 3rd Qu.:-0.4422

## Max. : 7.56330 Max. :11.2734

##

## skewness\_roll\_dumbbell skewness\_pitch\_dumbbell skewness\_yaw\_dumbbell

## Min. :-2.61100 Min. :-2.0501 Mode:logical

## 1st Qu.: 0.08190 1st Qu.:-0.2160 NA's:4024

|  |
| --- |
| ## Median : 0.08190 Median :-0.2160  ## Mean : 0.08043 Mean :-0.2133  ## 3rd Qu.: 0.08190 3rd Qu.:-0.2160  ## Max. : 2.38140 Max. : 2.7832  ##  ## max\_roll\_dumbbell max\_picth\_dumbbell max\_yaw\_dumbbell min\_roll\_dumbbell  ## Min. :-70.90 Min. :-84.5 Min. :-2.10000 Min. :-134.70  ## 1st Qu.: 41.85 1st Qu.:133.0 1st Qu.:-0.10000 1st Qu.: -26.75  ## Median : 41.85 Median :133.0 Median :-0.10000 Median : -26.75  ## Mean : 41.68 Mean :132.0 Mean :-0.09058 Mean : -26.77  ## 3rd Qu.: 41.85 3rd Qu.:133.0 3rd Qu.:-0.10000 3rd Qu.: -26.75  ## Max. : 97.30 Max. :152.9 Max. : 7.60000 Max. : 26.80 ##  ## min\_pitch\_dumbbell min\_yaw\_dumbbell amplitude\_roll\_dumbbell  ## Min. :-129.3 Min. :-2.10000 Min. : 0.00  ## 1st Qu.: 20.2 1st Qu.:-0.10000 1st Qu.: 55.71  ## Median : 20.2 Median :-0.10000 Median : 55.71  ## Mean : 20.1 Mean :-0.09058 Mean : 55.84  ## 3rd Qu.: 20.2 3rd Qu.:-0.10000 3rd Qu.: 55.71  ## Max. : 122.9 Max. : 7.60000 Max. :171.75  ##  ## amplitude\_pitch\_dumbbell amplitude\_yaw\_dumbbell total\_accel\_dumbbell  ## Min. : 0.00 Min. :0 Min. : 1.00  ## 1st Qu.: 54.74 1st Qu.:0 1st Qu.: 6.00  ## Median : 54.74 Median :0 Median : 9.00  ## Mean : 55.13 Mean :0 Mean :12.02  ## 3rd Qu.: 54.74 3rd Qu.:0 3rd Qu.:14.00  ## Max. :217.33 Max. :0 Max. :37.00 ## NA's :3936  ## var\_accel\_dumbbell avg\_roll\_dumbbell stddev\_roll\_dumbbell  ## Min. : 0.000 Min. :-110.933 Min. : 0.00  ## 1st Qu.: 2.416 1st Qu.: -5.118 1st Qu.: 17.06  ## Median : 2.416 Median : -5.118 Median : 17.06  ## Mean : 2.571 Mean : -4.948 Mean : 17.26  ## 3rd Qu.: 2.416 3rd Qu.: -5.118 3rd Qu.: 17.06  ## Max. :230.428 Max. : 117.404 Max. :103.12  ##  ## var\_roll\_dumbbell avg\_pitch\_dumbbell stddev\_pitch\_dumbbell  ## Min. : 0.0 Min. :-70.92 Min. : 0.00  ## 1st Qu.: 291.0 1st Qu.: 13.93 1st Qu.:14.11  ## Median : 291.0 Median : 13.93 Median :14.11  ## Mean : 314.4 Mean : 13.70 Mean :14.13  ## 3rd Qu.: 291.0 3rd Qu.: 13.93 3rd Qu.:14.11  ## Max. :10634.5 Max. : 57.45 Max. :48.43  ##  ## var\_pitch\_dumbbell avg\_yaw\_dumbbell stddev\_yaw\_dumbbell var\_yaw\_dumbbell  ## Min. : 0.0 Min. :-105.65 Min. : 0.00 Min. : 0.0  ## 1st Qu.: 199.1 1st Qu.: 64.71 1st Qu.:13.57 1st Qu.: 184.6  ## Median : 199.1 Median : 64.71 Median :13.57 Median : 184.6 |

## Mean : 202.2 Mean : 64.41 Mean :13.69 Mean : 193.2

## 3rd Qu.: 199.1 3rd Qu.: 64.71 3rd Qu.:13.57 3rd Qu.: 184.6

## Max. :2345.4 Max. : 129.93 Max. :71.06 Max. :5049.5

##

## gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x

## Min. :-1.4300 Min. :-2.04000 Min. :-1.4600 Min. :-237.000

## 1st Qu.:-0.0200 1st Qu.:-0.27000 1st Qu.:-0.3300 1st Qu.: -6.000

## Median : 0.3200 Median :-0.06000 Median :-0.1300 Median : 11.000

## Mean : 0.2487 Mean :-0.04674 Mean :-0.1337 Mean : -7.091

## 3rd Qu.: 0.5300 3rd Qu.: 0.14000 3rd Qu.: 0.0500 3rd Qu.: 23.000

## Max. : 1.4800 Max. : 4.37000 Max. : 1.8900 Max. : 217.000

##

## accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y

## Min. :-163.00 Min. :-273.00 Min. :-638.00 Min. :-730.0

## 1st Qu.: -28.00 1st Qu.: 12.00 1st Qu.:-515.00 1st Qu.:-544.0

## Median : -2.00 Median : 51.00 Median : 107.50 Median :-486.0

## Mean : 12.83 Mean : 16.63 Mean : 10.55 Mean :-115.7

## 3rd Qu.: 47.00 3rd Qu.: 79.00 3rd Qu.: 506.00 3rd Qu.: 304.0

## Max. : 281.00 Max. : 122.00 Max. : 579.00 Max. : 618.0

##

## magnet\_dumbbell\_z roll\_forearm pitch\_forearm yaw\_forearm

## Min. :-262.00 Min. :-180.0 Min. :-64.00 Min. :-180.00

## 1st Qu.:-101.00 1st Qu.:-115.0 1st Qu.: 0.00 1st Qu.:-106.00

## Median : -59.00 Median : 89.5 Median : 19.70 Median : 83.50

## Mean : -41.12 Mean : 36.1 Mean : 18.57 Mean : 17.79

## 3rd Qu.: 1.00 3rd Qu.: 136.0 3rd Qu.: 43.90 3rd Qu.: 108.00

## Max. : 300.00 Max. : 180.0 Max. : 86.90 Max. : 180.00

## ## kurtosis\_roll\_forearm kurtosis\_picth\_forearm kurtosis\_yaw\_forearm

## Min. :-1.796 Min. :-6.0000 Mode:logical

## 1st Qu.:-1.095 1st Qu.:-0.9752 NA's:4024

## Median :-1.095 Median :-0.9752

## Mean :-1.088 Mean :-0.9469

## 3rd Qu.:-1.095 3rd Qu.:-0.9752

## Max. : 6.651 Max. :28.5654

##

## skewness\_roll\_forearm skewness\_pitch\_forearm skewness\_yaw\_forearm

## Min. :-1.71990 Min. :-4.5751 Mode:logical

## 1st Qu.:-0.05065 1st Qu.: 0.1729 NA's:4024

## Median :-0.05065 Median : 0.1729

## Mean :-0.04793 Mean : 0.1686

## 3rd Qu.:-0.05065 3rd Qu.: 0.1729

## Max. : 2.23660 Max. : 3.5998

##

## max\_roll\_forearm max\_picth\_forearm max\_yaw\_forearm min\_roll\_forearm

## Min. :-63.90 Min. :-152.0 Min. :-1.800 Min. :-64.000

## 1st Qu.: 49.60 1st Qu.: 168.0 1st Qu.:-1.100 1st Qu.: 4.650

## Median : 49.60 Median : 168.0 Median :-1.100 Median : 4.650

## Mean : 49.25 Mean : 166.8 Mean :-1.093 Mean : 4.614

## 3rd Qu.: 49.60 3rd Qu.: 168.0 3rd Qu.:-1.100 3rd Qu.: 4.650

## Max. : 86.90 Max. : 180.0 Max. : 6.700 Max. : 47.500

##

## min\_pitch\_forearm min\_yaw\_forearm amplitude\_roll\_forearm

## Min. :-180.0 Min. :-1.800 Min. : 0.00

## 1st Qu.:-168.5 1st Qu.:-1.100 1st Qu.:32.20

## Median :-168.5 Median :-1.100 Median :32.20

## Mean :-166.6 Mean :-1.093 Mean :32.16

## 3rd Qu.:-168.5 3rd Qu.:-1.100 3rd Qu.:32.20

## Max. : 125.0 Max. : 6.700 Max. :77.10

##

## amplitude\_pitch\_forearm amplitude\_yaw\_forearm total\_accel\_forearm

## Min. : 0.0 Min. :0 Min. :10.00

## 1st Qu.:341.5 1st Qu.:0 1st Qu.:30.00

## Median :341.5 Median :0 Median :35.00

## Mean :338.3 Mean :0 Mean :34.38

## 3rd Qu.:341.5 3rd Qu.:0 3rd Qu.:37.00

## Max. :359.0 Max. :0 Max. :59.00

## NA's :3944

## var\_accel\_forearm avg\_roll\_forearm stddev\_roll\_forearm var\_roll\_forearm

## Min. : 0.00 Min. :-145.14 Min. : 0.00 Min. : 0

## 1st Qu.: 14.08 1st Qu.: 27.86 1st Qu.: 45.16 1st Qu.: 2749

## Median : 14.08 Median : 27.86 Median : 45.16 Median : 2749

## Mean : 14.43 Mean : 28.13 Mean : 45.66 Mean : 2889

## 3rd Qu.: 14.08 3rd Qu.: 27.86 3rd Qu.: 45.16 3rd Qu.: 2749

## Max. :124.18 Max. : 151.25 Max. :176.48 Max. :31145 ##

## avg\_pitch\_forearm stddev\_pitch\_forearm var\_pitch\_forearm

## Min. :-63.90 Min. : 0.000 Min. : 0.00

## 1st Qu.: 25.36 1st Qu.: 8.907 1st Qu.: 79.33

## Median : 25.36 Median : 8.907 Median : 79.33

## Mean : 25.18 Mean : 8.921 Mean : 80.97

## 3rd Qu.: 25.36 3rd Qu.: 8.907 3rd Qu.: 79.33

## Max. : 68.17 Max. :26.729 Max. :714.45

##

## avg\_yaw\_forearm stddev\_yaw\_forearm var\_yaw\_forearm gyros\_forearm\_x

## Min. :-152.33 Min. : 0.00 Min. : 0 Min. :-1.8800

## 1st Qu.: 17.10 1st Qu.: 74.28 1st Qu.: 5542 1st Qu.:-0.1400

## Median : 17.10 Median : 74.28 Median : 5542 Median : 0.0600

## Mean : 17.13 Mean : 74.01 Mean : 5578 Mean : 0.1076

## 3rd Qu.: 17.10 3rd Qu.: 74.28 3rd Qu.: 5542 3rd Qu.: 0.4200

## Max. : 132.59 Max. :197.51 Max. :39009 Max. : 1.8100

##

## gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x

## Min. :-5.730000 Min. :-2.58000 Min. :-328.000

## 1st Qu.:-1.780000 1st Qu.:-0.31000 1st Qu.:-117.000

## Median :-0.020000 Median :-0.02000 Median : -6.000

## Mean :-0.004108 Mean : 0.09302 Mean : -6.445

## 3rd Qu.: 1.830000 3rd Qu.: 0.48000 3rd Qu.: 113.000

## Max. : 5.170000 Max. : 3.35000 Max. : 279.000

##

## accel\_forearm\_y accel\_forearm\_z magnet\_forearm\_x magnet\_forearm\_y

|  |
| --- |
| ## Min. :-467.00 Min. :-366 Min. :-1160.0 Min. :-725.0  ## 1st Qu.: 75.75 1st Qu.:-210 1st Qu.: -589.0 1st Qu.: -76.0  ## Median : 229.50 Median :-181 Median : -330.5 Median : 653.0  ## Mean : 171.47 Mean :-163 Mean : -348.7 Mean : 358.6  ## 3rd Qu.: 297.00 3rd Qu.:-150 3rd Qu.: -152.0 3rd Qu.: 747.0  ## Max. : 575.00 Max. : 239 Max. : 413.0 Max. :1440.0  ##  ## magnet\_forearm\_z classe  ## Min. :-876.0 A:1365  ## 1st Qu.: 370.8 B: 901  ## Median : 560.0 C: 112  ## Mean : 475.2 D: 276  ## 3rd Qu.: 670.0 E:1370  ## Max. :1040.0  ## **summary**(data**$**classe)  ## A B C D E ## 1365 901 112 276 1370 **names**(data)  ## [1] "user\_name" "raw\_timestamp\_part\_1"  ## [3] "raw\_timestamp\_part\_2" "cvtd\_timestamp"  ## [5] "new\_window" "num\_window"  ## [7] "roll\_belt" "pitch\_belt"  ## [9] "yaw\_belt" "total\_accel\_belt"  ## [11] "kurtosis\_roll\_belt" "kurtosis\_picth\_belt"  ## [13] "skewness\_roll\_belt" "skewness\_roll\_belt.1"  ## [15] "max\_roll\_belt" "max\_picth\_belt"  ## [17] "max\_yaw\_belt" "min\_roll\_belt"  ## [19] "min\_pitch\_belt" "min\_yaw\_belt"  ## [21] "amplitude\_roll\_belt" "amplitude\_pitch\_belt"  ## [23] "amplitude\_yaw\_belt" "var\_total\_accel\_belt"  ## [25] "avg\_roll\_belt" "stddev\_roll\_belt"  ## [27] "var\_roll\_belt" "avg\_pitch\_belt"  ## [29] "stddev\_pitch\_belt" "var\_pitch\_belt"  ## [31] "avg\_yaw\_belt" "stddev\_yaw\_belt"  ## [33] "var\_yaw\_belt" "gyros\_belt\_x"  ## [35] "gyros\_belt\_y" "gyros\_belt\_z"  ## [37] "accel\_belt\_x" "accel\_belt\_y"  ## [39] "accel\_belt\_z" "magnet\_belt\_x"  ## [41] "magnet\_belt\_y" "magnet\_belt\_z"  ## [43] "roll\_arm" "pitch\_arm"  ## [45] "yaw\_arm" "total\_accel\_arm"  ## [47] "var\_accel\_arm" "avg\_roll\_arm"  ## [49] "stddev\_roll\_arm" "var\_roll\_arm"  ## [51] "avg\_pitch\_arm" "stddev\_pitch\_arm"  ## [53] "var\_pitch\_arm" "avg\_yaw\_arm" |

## [55] "stddev\_yaw\_arm" "var\_yaw\_arm"

## [57] "gyros\_arm\_x" "gyros\_arm\_y"

## [59] "gyros\_arm\_z" "accel\_arm\_x"

## [61] "accel\_arm\_y" "accel\_arm\_z"

## [63] "magnet\_arm\_x" "magnet\_arm\_y"

## [65] "magnet\_arm\_z" "kurtosis\_roll\_arm"

## [67] "kurtosis\_picth\_arm" "kurtosis\_yaw\_arm"

## [69] "skewness\_roll\_arm" "skewness\_pitch\_arm"

## [71] "skewness\_yaw\_arm" "max\_roll\_arm"

## [73] "max\_picth\_arm" "max\_yaw\_arm"

## [75] "min\_roll\_arm" "min\_pitch\_arm"

## [77] "min\_yaw\_arm" "amplitude\_roll\_arm"

## [79] "amplitude\_pitch\_arm" "amplitude\_yaw\_arm"

## [81] "roll\_dumbbell" "pitch\_dumbbell"

## [83] "yaw\_dumbbell" "kurtosis\_roll\_dumbbell"

## [85] "kurtosis\_picth\_dumbbell" "kurtosis\_yaw\_dumbbell"

## [87] "skewness\_roll\_dumbbell" "skewness\_pitch\_dumbbell"

## [89] "skewness\_yaw\_dumbbell" "max\_roll\_dumbbell"

## [91] "max\_picth\_dumbbell" "max\_yaw\_dumbbell"

## [93] "min\_roll\_dumbbell" "min\_pitch\_dumbbell"

## [95] "min\_yaw\_dumbbell" "amplitude\_roll\_dumbbell"

## [97] "amplitude\_pitch\_dumbbell" "amplitude\_yaw\_dumbbell"

## [99] "total\_accel\_dumbbell" "var\_accel\_dumbbell"

## [101] "avg\_roll\_dumbbell" "stddev\_roll\_dumbbell"

## [103] "var\_roll\_dumbbell" "avg\_pitch\_dumbbell"

## [105] "stddev\_pitch\_dumbbell" "var\_pitch\_dumbbell"

## [107] "avg\_yaw\_dumbbell" "stddev\_yaw\_dumbbell"

## [109] "var\_yaw\_dumbbell" "gyros\_dumbbell\_x"

## [111] "gyros\_dumbbell\_y" "gyros\_dumbbell\_z"

## [113] "accel\_dumbbell\_x" "accel\_dumbbell\_y"

## [115] "accel\_dumbbell\_z" "magnet\_dumbbell\_x"

## [117] "magnet\_dumbbell\_y" "magnet\_dumbbell\_z"

## [119] "roll\_forearm" "pitch\_forearm"

## [121] "yaw\_forearm" "kurtosis\_roll\_forearm"

## [123] "kurtosis\_picth\_forearm" "kurtosis\_yaw\_forearm"

## [125] "skewness\_roll\_forearm" "skewness\_pitch\_forearm"

## [127] "skewness\_yaw\_forearm" "max\_roll\_forearm"

## [129] "max\_picth\_forearm" "max\_yaw\_forearm"

## [131] "min\_roll\_forearm" "min\_pitch\_forearm"

## [133] "min\_yaw\_forearm" "amplitude\_roll\_forearm"

## [135] "amplitude\_pitch\_forearm" "amplitude\_yaw\_forearm"

## [137] "total\_accel\_forearm" "var\_accel\_forearm"

## [139] "avg\_roll\_forearm" "stddev\_roll\_forearm"

## [141] "var\_roll\_forearm" "avg\_pitch\_forearm"

## [143] "stddev\_pitch\_forearm" "var\_pitch\_forearm"

## [145] "avg\_yaw\_forearm" "stddev\_yaw\_forearm"

## [147] "var\_yaw\_forearm" "gyros\_forearm\_x"

## [149] "gyros\_forearm\_y" "gyros\_forearm\_z"

## [151] "accel\_forearm\_x" "accel\_forearm\_y"

## [153] "accel\_forearm\_z" "magnet\_forearm\_x" ## [155] "magnet\_forearm\_y" "magnet\_forearm\_z"

|  |
| --- |
| ## [157] "classe"  **library**(devtools) **install\_github**('adam-m-mcelhinney/helpRFunctions')  ## Skipping install of 'helpRFunctions' from a github remote, the SHA1 (9eb16 e8c) has not changed since last install. ## Use `force = TRUE` to force installation **library**(helpRFunctions)  ## Loading required package: caret  ## Loading required package: lattice ## Loading required package: ggplot2  training<-data[1**:**4000,] testing<-data[4001**:**4024,] **dim**(training) ## [1] 4000 157 **str**(training)  ## 'data.frame': 4000 obs. of 157 variables:  ## $ user\_name : Factor w/ 5 levels "adelmo","carlitos",..: 3 3 3 3 3 3 3 3 3 3 ...  ## $ raw\_timestamp\_part\_1 : int 1322489729 1322489729 1322489729 1322489 729 1322489729 1322489729 1322489729 1322489729 1322489729 1322489729 ... ## $ raw\_timestamp\_part\_2 : int 34670 62641 70653 82654 90637 170626 190 665 242723 267551 274689 ...  ## $ cvtd\_timestamp : Factor w/ 7 levels "2/12/2011 13:35",..: 2 2 2 2 2 2 2 2 2 2 ...  ## $ new\_window : Factor w/ 2 levels "no","yes": 1 1 1 1 1 1 1 1 1 1 ...  ## $ num\_window : int 1 1 1 1 1 1 1 1 1 1 ...  ## $ roll\_belt : num 3.7 3.66 3.58 3.56 3.57 3.45 3.31 2.91 2 .31 2 ...  ## $ pitch\_belt : num 41.6 42.8 43.7 44.4 45.1 45.6 46.2 46.9 47.4 47.7 ...  ## $ yaw\_belt : num -82.8 -82.5 -82.3 -82.1 -81.9 -81.9 -81.  9 -82.2 -82.6 -82.8 ...  ## $ total\_accel\_belt : int 3 2 1 1 1 1 3 4 2 3 ...  ## $ kurtosis\_roll\_belt : num -1.04 -1.04 -1.04 -1.04 -1.04 ...  ## $ kurtosis\_picth\_belt : num -0.391 -0.391 -0.391 -0.391 -0.391 ... ## $ skewness\_roll\_belt : num 0.00541 0.00541 0.00541 0.00541 0.00541 ...  ## $ skewness\_roll\_belt.1 : num 0.0451 0.0451 0.0451 0.0451 0.0451 ... ## $ max\_roll\_belt : num -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 -4.1 ... |

## $ max\_picth\_belt : int 20 20 20 20 20 20 20 20 20 20 ...

## $ max\_yaw\_belt : num -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ... ## $ min\_roll\_belt : num -7.25 -7.25 -7.25 -7.25 -7.25 -7.25 -7.2 5 -7.25 -7.25 -7.25 ...

## $ min\_pitch\_belt : int 18 18 18 18 18 18 18 18 18 18 ...

## $ min\_yaw\_belt : num -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 ...

## $ amplitude\_roll\_belt : num 1.34 1.34 1.34 1.34 1.34 ...

## $ amplitude\_pitch\_belt : int 2 2 2 2 2 2 2 2 2 2 ...

## $ amplitude\_yaw\_belt : int 0 0 0 0 0 0 0 0 0 0 ...

## $ var\_total\_accel\_belt : num 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 ...

## $ avg\_roll\_belt : num 122 122 122 122 122 ...

## $ stddev\_roll\_belt : num 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 ...

## $ var\_roll\_belt : num 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 ...

## $ avg\_pitch\_belt : num 25.8 25.8 25.8 25.8 25.8 ...

## $ stddev\_pitch\_belt : num 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 ...

## $ var\_pitch\_belt : num 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 ...

## $ avg\_yaw\_belt : num -4.95 -4.95 -4.95 -4.95 -4.95 -4.95 -4.9 5 -4.95 -4.95 -4.95 ...

## $ stddev\_yaw\_belt : num 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 ...

## $ var\_yaw\_belt : num 0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.17 ...

## $ gyros\_belt\_x : num 2.02 1.96 1.88 1.8 1.77 1.75 1.78 1.75 1 .65 1.48 ...

## $ gyros\_belt\_y : num 0.18 0.14 0.08 0.03 0 -0.03 -0.06 -0.06 -0.03 -0.06 ...

## $ gyros\_belt\_z : num 0.02 0.05 0.05 0.08 0.13 0.16 0.15 0.23 0.33 0.21 ...

## $ accel\_belt\_x : int -3 -2 -2 -6 -4 1 1 2 -1 -18 ...

## $ accel\_belt\_y : int -18 -13 -6 -5 -9 -9 -24 -36 -19 18 ...

## $ accel\_belt\_z : int 22 16 8 7 0 -5 -8 -9 -7 1 ...

## $ magnet\_belt\_x : int 387 405 409 422 418 432 438 440 443 449 ...

## $ magnet\_belt\_y : int 525 512 511 513 508 510 508 503 507 499 ...

## $ magnet\_belt\_z : int -267 -254 -244 -221 -208 -189 -176 -163 -140 -132 ...

## $ roll\_arm : num 132 129 125 120 115 110 104 98.6 93.2 88 .5 ...

## $ pitch\_arm : num -43.7 -45.3 -46.8 -48.1 -49.1 -49.6 -49. 9 -49.7 -49 -48.1 ...

## $ yaw\_arm : num -53.6 -49 -43.7 -38.1 -31.7 -25.8 -18.5 -11.4 -4.49 1.82 ...

## $ total\_accel\_arm : int 38 38 35 35 34 33 29 28 27 22 ...

## $ var\_accel\_arm : num 65.1 65.1 65.1 65.1 65.1 ...

## $ avg\_roll\_arm : num 76.2 76.2 76.2 76.2 76.2 ...

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| ## $ stddev\_roll\_arm : num 16.1 16.1 16.1 16.1 16.1 ...  ## $ var\_roll\_arm : num 259 259 259 259 259 ...  ## $ avg\_pitch\_arm : num -10.2 -10.2 -10.2 -10.2 -10.2 ...  ## $ stddev\_pitch\_arm : num 10.7 10.7 10.7 10.7 10.7 ... ## $ var\_pitch\_arm : num 114 114 114 114 114 ...  ## $ avg\_yaw\_arm : num 19.1 19.1 19.1 19.1 19.1 ...  ## $ stddev\_yaw\_arm : num 35.9 35.9 35.9 35.9 35.9 ...  ## $ var\_yaw\_arm : num 1287 1287 1287 1287 1287 ...  ## $ gyros\_arm\_x : num 2.65 2.79 2.91 3.08 3.2 3.31 3.5 3.53 3. 4 3.48 ...  ## $ gyros\_arm\_y : num -0.61 -0.64 -0.69 -0.72 -0.77 -0.83 -0.8 3 -0.83 -0.83 -0.8 ...  ## $ gyros\_arm\_z : num -0.02 -0.11 -0.15 -0.23 -0.25 -0.3 -0.31 -0.21 -0.11 -0.15 ...  ## $ accel\_arm\_x : int 143 146 156 158 163 160 165 153 143 135 ...  ## $ accel\_arm\_y : int 30 35 44 52 55 59 67 70 78 96 ... ## $ accel\_arm\_z : int -346 -339 -307 -305 -288 -274 -225 -218 -205 -134 ...  ## $ magnet\_arm\_x : int 556 599 613 646 670 696 721 725 740 741 ...  ## $ magnet\_arm\_y : int -205 -206 -198 -186 -175 -174 -161 -152 -133 -115 ...  ## $ magnet\_arm\_z : int -374 -335 -319 -268 -241 -193 -121 -105 -43 14 ...  ## $ kurtosis\_roll\_arm : num -1.18 -1.18 -1.18 -1.18 -1.18 ...  ## $ kurtosis\_picth\_arm : num -0.969 -0.969 -0.969 -0.969 -0.969 ...  ## $ kurtosis\_yaw\_arm : num -0.87 -0.87 -0.87 -0.87 -0.87 ...  ## $ skewness\_roll\_arm : num 0.124 0.124 0.124 0.124 0.124 ...  ## $ skewness\_pitch\_arm : num -0.103 -0.103 -0.103 -0.103 -0.103 ...  ## $ skewness\_yaw\_arm : num 0.0598 0.0598 0.0598 0.0598 0.0598 ... ## $ max\_roll\_arm : num 8.45 8.45 8.45 8.45 8.45 8.45 8.45 8.45 8.45 8.45 ...  ## $ max\_picth\_arm : num 77.2 77.2 77.2 77.2 77.2 ...  ## $ max\_yaw\_arm : int 38 38 38 38 38 38 38 38 38 38 ...  ## $ min\_roll\_arm : num -33.6 -33.6 -33.6 -33.6 -33.6 -33.6 -33. 6 -33.6 -33.6 -33.6 ...  ## $ min\_pitch\_arm : num -58.6 -58.6 -58.6 -58.6 -58.6 -58.6 -58.  6 -58.6 -58.6 -58.6 ...  ## $ min\_yaw\_arm : int 10 10 10 10 10 10 10 10 10 10 ...  ## $ amplitude\_roll\_arm : num 36.9 36.9 36.9 36.9 36.9 ...  ## $ amplitude\_pitch\_arm : num 122 122 122 122 122 ...  ## $ amplitude\_yaw\_arm : int 27 27 27 27 27 27 27 27 27 27 ...  ## $ roll\_dumbbell : num 51.2 55.8 55.5 55.9 55.2 ...  ## $ pitch\_dumbbell : num 11.7 9.65 6.88 11.08 11.43 ...  ## $ yaw\_dumbbell : num 104.3 100.2 101.1 99.8 100.4 ...  ## $ kurtosis\_roll\_dumbbell : num -0.0959 -0.0959 -0.0959 -0.0959 -0.0959 ...  ## $ kurtosis\_picth\_dumbbell : num -0.442 -0.442 -0.442 -0.442 -0.442 ... |

## $ kurtosis\_yaw\_dumbbell : logi NA NA NA NA NA NA ...

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| ## $ skewness\_roll\_dumbbell : num 0.0819 0.0819 0.0819 0.0819 0.0819 0.081 9 0.0819 0.0819 0.0819 0.0819 ...  ## $ skewness\_pitch\_dumbbell : num -0.216 -0.216 -0.216 -0.216 -0.216 -0.21 6 -0.216 -0.216 -0.216 -0.216 ...  ## $ skewness\_yaw\_dumbbell : logi NA NA NA NA NA NA ...  ## $ max\_roll\_dumbbell : num 41.9 41.9 41.9 41.9 41.9 ...  ## $ max\_picth\_dumbbell : num 133 133 133 133 133 133 133 133 133 133 ...  ## $ max\_yaw\_dumbbell : num -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 ...  ## $ min\_roll\_dumbbell : num -26.8 -26.8 -26.8 -26.8 -26.8 ... ## $ min\_pitch\_dumbbell : num 20.2 20.2 20.2 20.2 20.2 20.2 20.2 20.2 20.2 20.2 ...  ## $ min\_yaw\_dumbbell : num -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 -0.1 ...  ## $ amplitude\_roll\_dumbbell : num 55.7 55.7 55.7 55.7 55.7 ...  ## $ amplitude\_pitch\_dumbbell: num 54.7 54.7 54.7 54.7 54.7 ...  ## $ amplitude\_yaw\_dumbbell : int NA NA NA NA NA NA NA NA NA NA ...  ## $ total\_accel\_dumbbell : int 4 4 4 5 4 4 4 4 4 4 ...  ## [list output truncated] **summary**(training)  ## user\_name raw\_timestamp\_part\_1 raw\_timestamp\_part\_2  ## adelmo : 311 Min. :1.322e+09 Min. : 297  ## carlitos:1580 1st Qu.:1.323e+09 1st Qu.:240437  ## eurico : 88 Median :1.323e+09 Median :492290  ## jeremy : 4 Mean :1.323e+09 Mean :489477  ## pedro :2017 3rd Qu.:1.323e+09 3rd Qu.:734821  ## Max. :1.323e+09 Max. :996453  ##  ## cvtd\_timestamp new\_window num\_window roll\_belt  ## 2/12/2011 13:35 : 311 no :3913 Min. : 1.00 Min. :-28.90  ## 28/11/2011 14:15: 88 yes: 87 1st Qu.:24.00 1st Qu.: 1.35  ## 30/11/2011 17:12: 4 Median :46.00 Median :122.00  ## 5/12/2011 11:23 : 337 Mean :46.06 Mean : 73.02  ## 5/12/2011 11:25 :1243 3rd Qu.:68.00 3rd Qu.:124.00  ## 5/12/2011 14:22 : 456 Max. :91.00 Max. :159.00  ## 5/12/2011 14:23 :1561  ## pitch\_belt yaw\_belt total\_accel\_belt kurtosis\_roll\_belt  ## Min. :-56.20 Min. :-179.00 Min. : 0.00 Min. :-3.333  ## 1st Qu.: 6.20 1st Qu.: -93.10 1st Qu.: 3.00 1st Qu.:-1.036  ## Median : 25.50 Median : -5.02 Median :19.00 Median :-1.036  ## Mean : 14.09 Mean : -31.14 Mean :12.73 Mean :-1.027  ## 3rd Qu.: 26.40 3rd Qu.: -2.67 3rd Qu.:20.00 3rd Qu.:-1.036  ## Max. : 60.30 Max. : 179.00 Max. :26.00 Max. : 7.515 ##  ## kurtosis\_picth\_belt skewness\_roll\_belt skewness\_roll\_belt.1  ## Min. :-2.1212 Min. :-3.031527 Min. :-6.63325 |

## 1st Qu.:-0.3913 1st Qu.: 0.005406 1st Qu.: 0.04512

## Median :-0.3913 Median : 0.005406 Median : 0.04512

## Mean :-0.3497 Mean : 0.003849 Mean : 0.03965

## 3rd Qu.:-0.3913 3rd Qu.: 0.005406 3rd Qu.: 0.04512

## Max. :54.0000 Max. : 2.713152 Max. : 7.34847

##

## max\_roll\_belt max\_picth\_belt max\_yaw\_belt min\_roll\_belt

## Min. :-94.400 Min. : 3.00 Min. :-3.3000 Min. :-179.000

## 1st Qu.: -4.100 1st Qu.:20.00 1st Qu.:-1.0000 1st Qu.: -7.250

## Median : -4.100 Median :20.00 Median :-1.0000 Median : -7.250

## Mean : -4.629 Mean :19.87 Mean :-0.9917 Mean : -7.842

## 3rd Qu.: -4.100 3rd Qu.:20.00 3rd Qu.:-1.0000 3rd Qu.: -7.250

## Max. :179.000 Max. :26.00 Max. : 7.5000 Max. : 157.000

##

## min\_pitch\_belt min\_yaw\_belt amplitude\_roll\_belt

## Min. : 0.00 Min. :-3.3000 Min. : 0.000

## 1st Qu.:18.00 1st Qu.:-1.0000 1st Qu.: 1.345

## Median :18.00 Median :-1.0000 Median : 1.345

## Mean :17.86 Mean :-0.9917 Mean : 1.447

## 3rd Qu.:18.00 3rd Qu.:-1.0000 3rd Qu.: 1.345

## Max. :20.00 Max. : 7.5000 Max. :358.000

##

## amplitude\_pitch\_belt amplitude\_yaw\_belt var\_total\_accel\_belt

## Min. : 0.000 Min. :0 Min. : 0.000

## 1st Qu.: 2.000 1st Qu.:0 1st Qu.: 0.300

## Median : 2.000 Median :0 Median : 0.300

## Mean : 2.014 Mean :0 Mean : 0.315

## 3rd Qu.: 2.000 3rd Qu.:0 3rd Qu.: 0.300

## Max. :21.000 Max. :0 Max. :18.200

##

## avg\_roll\_belt stddev\_roll\_belt var\_roll\_belt avg\_pitch\_belt

## Min. :-27.4 Min. :0.0000 Min. : 0.0000 Min. :-49.40

## 1st Qu.:121.9 1st Qu.:0.6000 1st Qu.: 0.3500 1st Qu.: 25.75

## Median :121.9 Median :0.6000 Median : 0.3500 Median : 25.75

## Mean :120.8 Mean :0.6259 Mean : 0.5383 Mean : 25.49

## 3rd Qu.:121.9 3rd Qu.:0.6000 3rd Qu.: 0.3500 3rd Qu.: 25.75

## Max. :154.5 Max. :8.5000 Max. :71.8000 Max. : 59.70

##

## stddev\_pitch\_belt var\_pitch\_belt avg\_yaw\_belt stddev\_yaw\_belt

## Min. :0.0000 Min. : 0.000 Min. :-94.400 Min. : 0.0000

## 1st Qu.:0.3500 1st Qu.: 0.100 1st Qu.: -4.950 1st Qu.: 0.4000

## Median :0.3500 Median : 0.100 Median : -4.950 Median : 0.4000

## Mean :0.3574 Mean : 0.129 Mean : -5.518 Mean : 0.4452

## 3rd Qu.:0.3500 3rd Qu.: 0.100 3rd Qu.: -4.950 3rd Qu.: 0.4000

## Max. :6.2000 Max. :39.000 Max. :158.600 Max. :163.1000

##

## var\_yaw\_belt gyros\_belt\_x gyros\_belt\_y gyros\_belt\_z

## Min. : 0.000 Min. :-0.790 Min. :-0.4700 Min. :-0.7700

## 1st Qu.: 0.170 1st Qu.:-0.430 1st Qu.:-0.0300 1st Qu.:-0.4600

## Median : 0.170 Median :-0.240 Median :-0.0200 Median :-0.4100 ## Mean : 6.836 Mean :-0.181 Mean :-0.0087 Mean :-0.2452

## 3rd Qu.: 0.170 3rd Qu.: 0.020 3rd Qu.: 0.0000 3rd Qu.:-0.0200

## Max. :26610.320 Max. : 2.020 Max. : 0.4200 Max. : 0.8200

##

## accel\_belt\_x accel\_belt\_y accel\_belt\_z magnet\_belt\_x

## Min. :-120.00 Min. :-71.00 Min. :-244.00 Min. :-30.00

## 1st Qu.: -42.00 1st Qu.: 4.00 1st Qu.:-176.00 1st Qu.: -3.00

## Median : -33.00 Median : 65.00 Median :-165.50 Median : 2.00

## Mean : -24.27 Mean : 39.66 Mean : -94.28 Mean : 24.81

## 3rd Qu.: -16.00 3rd Qu.: 70.00 3rd Qu.: 20.00 3rd Qu.: 9.00

## Max. : 80.00 Max. :164.00 Max. : 77.00 Max. :485.00

##

## magnet\_belt\_y magnet\_belt\_z roll\_arm pitch\_arm

## Min. :428.0 Min. :-513.0 Min. :-180.00 Min. :-87.100

## 1st Qu.:577.0 1st Qu.:-380.0 1st Qu.: -34.85 1st Qu.:-32.300

## Median :585.0 Median :-366.0 Median : 71.95 Median : -8.815

## Mean :582.6 Mean :-340.7 Mean : 39.79 Mean :-10.700

## 3rd Qu.:601.0 3rd Qu.:-311.0 3rd Qu.: 124.00 3rd Qu.: 14.500

## Max. :652.0 Max. : 293.0 Max. : 180.00 Max. : 81.400

##

## yaw\_arm total\_accel\_arm var\_accel\_arm avg\_roll\_arm

## Min. :-180.000 Min. : 1.00 Min. : 0.00 Min. :-169.69

## 1st Qu.: -60.125 1st Qu.:15.00 1st Qu.: 65.10 1st Qu.: 76.22

## Median : 16.900 Median :25.00 Median : 65.10 Median : 76.22

## Mean : 2.597 Mean :24.86 Mean : 65.28 Mean : 75.36

## 3rd Qu.: 73.300 3rd Qu.:34.00 3rd Qu.: 65.10 3rd Qu.: 76.22

## Max. : 180.000 Max. :59.00 Max. :253.01 Max. : 160.78

##

## stddev\_roll\_arm var\_roll\_arm avg\_pitch\_arm stddev\_pitch\_arm

## Min. : 0.00 Min. : 0.0 Min. :-57.29 Min. : 0.00

## 1st Qu.: 16.10 1st Qu.: 259.4 1st Qu.:-10.17 1st Qu.:10.67

## Median : 16.10 Median : 259.4 Median :-10.17 Median :10.67

## Mean : 16.23 Mean : 283.7 Mean :-10.16 Mean :10.70

## 3rd Qu.: 16.10 3rd Qu.: 259.4 3rd Qu.:-10.17 3rd Qu.:10.67

## Max. :161.96 Max. :26232.2 Max. : 54.60 Max. :30.78

##

## var\_pitch\_arm avg\_yaw\_arm stddev\_yaw\_arm var\_yaw\_arm

## Min. : 0.0 Min. :-164.64 Min. : 0.00 Min. : 0

## 1st Qu.:113.8 1st Qu.: 19.06 1st Qu.: 35.88 1st Qu.: 1287

## Median :113.8 Median : 19.06 Median : 35.88 Median : 1287

## Mean :116.2 Mean : 18.69 Mean : 35.90 Mean : 1307

## 3rd Qu.:113.8 3rd Qu.: 19.06 3rd Qu.: 35.88 3rd Qu.: 1287

## Max. :947.3 Max. : 148.45 Max. :177.04 Max. :31345

##

## gyros\_arm\_x gyros\_arm\_y gyros\_arm\_z accel\_arm\_x

## Min. :-5.2000 Min. :-3.4400 Min. :-2.17000 Min. :-346.00

## 1st Qu.:-2.0925 1st Qu.:-0.9300 1st Qu.:-0.20000 1st Qu.: -89.00

## Median :-0.0200 Median :-0.0300 Median : 0.00000 Median : 23.00

## Mean :-0.1771 Mean :-0.1846 Mean : 0.04549 Mean : 33.03

## 3rd Qu.: 1.7200 3rd Qu.: 0.5800 3rd Qu.: 0.28000 3rd Qu.: 134.25 ## Max. : 4.3400 Max. : 2.4600 Max. : 3.02000 Max. : 434.00

##

## accel\_arm\_y accel\_arm\_z magnet\_arm\_x magnet\_arm\_y

## Min. :-252.00 Min. :-538.00 Min. :-515.0 Min. :-392.0

## 1st Qu.: -21.00 1st Qu.:-124.00 1st Qu.:-335.2 1st Qu.: -14.0

## Median : 22.00 Median : 5.00 Median : 273.5 Median : 269.0

## Mean : 27.02 Mean : -42.21 Mean : 192.5 Mean : 161.4

## 3rd Qu.: 98.00 3rd Qu.: 75.00 3rd Qu.: 653.0 3rd Qu.: 348.0

## Max. : 229.00 Max. : 209.00 Max. : 782.0 Max. : 482.0

##

## magnet\_arm\_z kurtosis\_roll\_arm kurtosis\_picth\_arm kurtosis\_yaw\_arm

## Min. :-573.0 Min. :-3.333 Min. :-2.0835 Min. :-1.6308

## 1st Qu.: -3.0 1st Qu.:-1.182 1st Qu.:-0.9691 1st Qu.:-0.8698

## Median : 432.0 Median :-1.182 Median :-0.9691 Median :-0.8698

## Mean : 252.3 Mean :-1.172 Mean :-0.9504 Mean :-0.8478

## 3rd Qu.: 515.0 3rd Qu.:-1.182 3rd Qu.:-0.9691 3rd Qu.:-0.8698

## Max. : 647.0 Max. :18.719 Max. :23.8408 Max. :36.0000

##

## skewness\_roll\_arm skewness\_pitch\_arm skewness\_yaw\_arm max\_roll\_arm

## Min. :-1.7457 Min. :-4.9942 Min. :-6.00000 Min. :-36.300

## 1st Qu.: 0.1235 1st Qu.:-0.1032 1st Qu.: 0.05976 1st Qu.: 8.450

## Median : 0.1235 Median :-0.1032 Median : 0.05976 Median : 8.450

## Mean : 0.1247 Mean :-0.1059 Mean : 0.05745 Mean : 8.472

## 3rd Qu.: 0.1235 3rd Qu.:-0.1032 3rd Qu.: 0.05976 3rd Qu.: 8.450

## Max. : 4.3945 Max. : 2.1711 Max. : 2.10699 Max. : 81.400

##

## max\_picth\_arm max\_yaw\_arm min\_roll\_arm min\_pitch\_arm

## Min. :-164.00 Min. : 3 Min. :-87.10 Min. :-180.00

## 1st Qu.: 77.25 1st Qu.:38 1st Qu.:-33.60 1st Qu.: -58.60

## Median : 77.25 Median :38 Median :-33.60 Median : -58.60

## Mean : 76.78 Mean :38 Mean :-33.48 Mean : -58.55

## 3rd Qu.: 77.25 3rd Qu.:38 3rd Qu.:-33.60 3rd Qu.: -58.60

## Max. : 180.00 Max. :59 Max. : 35.70 Max. : 146.00

##

## min\_yaw\_arm amplitude\_roll\_arm amplitude\_pitch\_arm amplitude\_yaw\_arm

## Min. : 1.00 Min. : 0.00 Min. : 0.0 Min. : 0.00

## 1st Qu.:10.00 1st Qu.:36.95 1st Qu.:121.5 1st Qu.:27.00

## Median :10.00 Median :36.95 Median :121.5 Median :27.00

## Mean :10.06 Mean :36.96 Mean :121.3 Mean :26.96

## 3rd Qu.:10.00 3rd Qu.:36.95 3rd Qu.:121.5 3rd Qu.:27.00

## Max. :34.00 Max. :90.00 Max. :360.0 Max. :52.00 ##

## roll\_dumbbell pitch\_dumbbell yaw\_dumbbell

## Min. :-152.782 Min. :-134.732 Min. :-129.33

## 1st Qu.: -34.555 1st Qu.: -13.297 1st Qu.: 21.09

## Median : -1.805 Median : 14.481 Median : 71.38

## Mean : 3.693 Mean : 5.088 Mean : 55.31

## 3rd Qu.: 58.532 3rd Qu.: 27.950 3rd Qu.: 121.91

## Max. : 139.729 Max. : 97.281 Max. : 152.92

##

## kurtosis\_roll\_dumbbell kurtosis\_picth\_dumbbell kurtosis\_yaw\_dumbbell

## Min. :-2.08890 Min. :-2.0889 Mode:logical

## 1st Qu.:-0.09595 1st Qu.:-0.4422 NA's:4000

## Median :-0.09595 Median :-0.4422

## Mean :-0.08657 Mean :-0.4310

## 3rd Qu.:-0.09595 3rd Qu.:-0.4422

## Max. : 7.56330 Max. :11.2734

##

## skewness\_roll\_dumbbell skewness\_pitch\_dumbbell skewness\_yaw\_dumbbell

## Min. :-2.61100 Min. :-2.0501 Mode:logical

## 1st Qu.: 0.08190 1st Qu.:-0.2160 NA's:4000

## Median : 0.08190 Median :-0.2160

## Mean : 0.08055 Mean :-0.2132

## 3rd Qu.: 0.08190 3rd Qu.:-0.2160

## Max. : 2.38140 Max. : 2.7832

##

## max\_roll\_dumbbell max\_picth\_dumbbell max\_yaw\_dumbbell min\_roll\_dumbbell

## Min. :-70.90 Min. :-84.5 Min. :-2.10000 Min. :-134.70

## 1st Qu.: 41.85 1st Qu.:133.0 1st Qu.:-0.10000 1st Qu.: -26.75

## Median : 41.85 Median :133.0 Median :-0.10000 Median : -26.75

## Mean : 41.68 Mean :132.0 Mean :-0.09047 Mean : -26.76

## 3rd Qu.: 41.85 3rd Qu.:133.0 3rd Qu.:-0.10000 3rd Qu.: -26.75

## Max. : 97.30 Max. :152.9 Max. : 7.60000 Max. : 26.80 ##

## min\_pitch\_dumbbell min\_yaw\_dumbbell amplitude\_roll\_dumbbell

## Min. :-129.30 Min. :-2.10000 Min. : 0.00

## 1st Qu.: 20.20 1st Qu.:-0.10000 1st Qu.: 55.71

## Median : 20.20 Median :-0.10000 Median : 55.71

## Mean : 20.09 Mean :-0.09047 Mean : 55.83

## 3rd Qu.: 20.20 3rd Qu.:-0.10000 3rd Qu.: 55.71

## Max. : 122.90 Max. : 7.60000 Max. :171.75

##

## amplitude\_pitch\_dumbbell amplitude\_yaw\_dumbbell total\_accel\_dumbbell

## Min. : 0.00 Min. :0 Min. : 1.00

## 1st Qu.: 54.74 1st Qu.:0 1st Qu.: 6.00

## Median : 54.74 Median :0 Median : 9.00

## Mean : 55.12 Mean :0 Mean :12.04

## 3rd Qu.: 54.74 3rd Qu.:0 3rd Qu.:14.00

## Max. :217.33 Max. :0 Max. :37.00

## NA's :3913

## var\_accel\_dumbbell avg\_roll\_dumbbell stddev\_roll\_dumbbell

## Min. : 0.000 Min. :-110.933 Min. : 0.00

## 1st Qu.: 2.416 1st Qu.: -5.118 1st Qu.: 17.06

## Median : 2.416 Median : -5.118 Median : 17.06

## Mean : 2.570 Mean : -4.934 Mean : 17.26

## 3rd Qu.: 2.416 3rd Qu.: -5.118 3rd Qu.: 17.06

## Max. :230.428 Max. : 117.404 Max. :103.12

##

## var\_roll\_dumbbell avg\_pitch\_dumbbell stddev\_pitch\_dumbbell

## Min. : 0.0 Min. :-70.92 Min. : 0.00

## 1st Qu.: 291.0 1st Qu.: 13.93 1st Qu.:14.11

## Median : 291.0 Median : 13.93 Median :14.11

## Mean : 314.2 Mean : 13.70 Mean :14.13

## 3rd Qu.: 291.0 3rd Qu.: 13.93 3rd Qu.:14.11

## Max. :10634.5 Max. : 57.45 Max. :48.43

##

## var\_pitch\_dumbbell avg\_yaw\_dumbbell stddev\_yaw\_dumbbell var\_yaw\_dumbbell

## Min. : 0.0 Min. :-105.65 Min. : 0.00 Min. : 0.0

## 1st Qu.: 199.1 1st Qu.: 64.71 1st Qu.:13.57 1st Qu.: 184.6

## Median : 199.1 Median : 64.71 Median :13.57 Median : 184.6

## Mean : 202.1 Mean : 64.40 Mean :13.69 Mean : 193.0

## 3rd Qu.: 199.1 3rd Qu.: 64.71 3rd Qu.:13.57 3rd Qu.: 184.6

## Max. :2345.4 Max. : 129.93 Max. :71.06 Max. :5049.5

##

## gyros\_dumbbell\_x gyros\_dumbbell\_y gyros\_dumbbell\_z accel\_dumbbell\_x

## Min. :-1.430 Min. :-2.04000 Min. :-1.4600 Min. :-237.000

## 1st Qu.:-0.020 1st Qu.:-0.27000 1st Qu.:-0.3300 1st Qu.: -6.000

## Median : 0.320 Median :-0.06000 Median :-0.1300 Median : 11.000

## Mean : 0.248 Mean :-0.04506 Mean :-0.1345 Mean : -7.231

## 3rd Qu.: 0.530 3rd Qu.: 0.14000 3rd Qu.: 0.0300 3rd Qu.: 23.000

## Max. : 1.480 Max. : 4.37000 Max. : 1.8900 Max. : 217.000

##

## accel\_dumbbell\_y accel\_dumbbell\_z magnet\_dumbbell\_x magnet\_dumbbell\_y

## Min. :-163.00 Min. :-273.00 Min. :-638.000 Min. :-730.0

## 1st Qu.: -28.00 1st Qu.: 12.00 1st Qu.:-516.000 1st Qu.:-544.0

## Median : -1.00 Median : 50.00 Median : 103.500 Median :-480.0

## Mean : 13.06 Mean : 16.28 Mean : 7.495 Mean :-113.2

## 3rd Qu.: 47.00 3rd Qu.: 79.00 3rd Qu.: 505.000 3rd Qu.: 305.0

## Max. : 281.00 Max. : 122.00 Max. : 579.000 Max. : 618.0

##

## magnet\_dumbbell\_z roll\_forearm pitch\_forearm yaw\_forearm

## Min. :-262.00 Min. :-180.00 Min. :-64.00 Min. :-180.0

## 1st Qu.:-100.00 1st Qu.:-118.00 1st Qu.: 0.00 1st Qu.:-106.0

## Median : -58.00 Median : 89.40 Median : 19.70 Median : 83.2

## Mean : -40.76 Mean : 35.47 Mean : 18.53 Mean : 17.2

## 3rd Qu.: 2.00 3rd Qu.: 135.00 3rd Qu.: 43.90 3rd Qu.: 107.2

## Max. : 300.00 Max. : 180.00 Max. : 86.90 Max. : 180.0

## ## kurtosis\_roll\_forearm kurtosis\_picth\_forearm kurtosis\_yaw\_forearm

## Min. :-1.796 Min. :-6.0000 Mode:logical

## 1st Qu.:-1.095 1st Qu.:-0.9752 NA's:4000

## Median :-1.095 Median :-0.9752

## Mean :-1.088 Mean :-0.9465

## 3rd Qu.:-1.095 3rd Qu.:-0.9752

## Max. : 6.651 Max. :28.5654

##

## skewness\_roll\_forearm skewness\_pitch\_forearm skewness\_yaw\_forearm

## Min. :-1.71990 Min. :-4.5751 Mode:logical

## 1st Qu.:-0.05065 1st Qu.: 0.1729 NA's:4000

## Median :-0.05065 Median : 0.1729

## Mean :-0.04779 Mean : 0.1687

## 3rd Qu.:-0.05065 3rd Qu.: 0.1729

## Max. : 2.23660 Max. : 3.5998

##

## max\_roll\_forearm max\_picth\_forearm max\_yaw\_forearm min\_roll\_forearm

## Min. :-63.90 Min. :-152.0 Min. :-1.800 Min. :-64.000

## 1st Qu.: 49.60 1st Qu.: 168.0 1st Qu.:-1.100 1st Qu.: 4.650

## Median : 49.60 Median : 168.0 Median :-1.100 Median : 4.650

## Mean : 49.25 Mean : 166.8 Mean :-1.093 Mean : 4.614

## 3rd Qu.: 49.60 3rd Qu.: 168.0 3rd Qu.:-1.100 3rd Qu.: 4.650

## Max. : 86.90 Max. : 180.0 Max. : 6.700 Max. : 47.500

##

## min\_pitch\_forearm min\_yaw\_forearm amplitude\_roll\_forearm

## Min. :-180.0 Min. :-1.800 Min. : 0.00

## 1st Qu.:-168.5 1st Qu.:-1.100 1st Qu.:32.20

## Median :-168.5 Median :-1.100 Median :32.20

## Mean :-166.6 Mean :-1.093 Mean :32.16

## 3rd Qu.:-168.5 3rd Qu.:-1.100 3rd Qu.:32.20

## Max. : 125.0 Max. : 6.700 Max. :77.10

##

## amplitude\_pitch\_forearm amplitude\_yaw\_forearm total\_accel\_forearm

## Min. : 0.0 Min. :0 Min. :11.00

## 1st Qu.:341.5 1st Qu.:0 1st Qu.:30.00

## Median :341.5 Median :0 Median :35.00

## Mean :338.2 Mean :0 Mean :34.37

## 3rd Qu.:341.5 3rd Qu.:0 3rd Qu.:37.00

## Max. :359.0 Max. :0 Max. :59.00

## NA's :3921

## var\_accel\_forearm avg\_roll\_forearm stddev\_roll\_forearm var\_roll\_forearm

## Min. : 0.00 Min. :-145.14 Min. : 0.00 Min. : 0

## 1st Qu.: 14.08 1st Qu.: 27.86 1st Qu.: 45.16 1st Qu.: 2749

## Median : 14.08 Median : 27.86 Median : 45.16 Median : 2749

## Mean : 14.40 Mean : 28.12 Mean : 45.64 Mean : 2886

## 3rd Qu.: 14.08 3rd Qu.: 27.86 3rd Qu.: 45.16 3rd Qu.: 2749

## Max. :109.09 Max. : 151.25 Max. :176.48 Max. :31145 ##

## avg\_pitch\_forearm stddev\_pitch\_forearm var\_pitch\_forearm

## Min. :-63.90 Min. : 0.000 Min. : 0.00

## 1st Qu.: 25.36 1st Qu.: 8.907 1st Qu.: 79.33

## Median : 25.36 Median : 8.907 Median : 79.33

## Mean : 25.18 Mean : 8.919 Mean : 80.93

## 3rd Qu.: 25.36 3rd Qu.: 8.907 3rd Qu.: 79.33

## Max. : 68.17 Max. :26.729 Max. :714.45

##

## avg\_yaw\_forearm stddev\_yaw\_forearm var\_yaw\_forearm gyros\_forearm\_x

## Min. :-152.33 Min. : 0.00 Min. : 0 Min. :-1.880

## 1st Qu.: 17.10 1st Qu.: 74.28 1st Qu.: 5542 1st Qu.:-0.140

## Median : 17.10 Median : 74.28 Median : 5542 Median : 0.060

## Mean : 17.14 Mean : 73.99 Mean : 5576 Mean : 0.111

## 3rd Qu.: 17.10 3rd Qu.: 74.28 3rd Qu.: 5542 3rd Qu.: 0.420

## Max. : 132.59 Max. :197.51 Max. :39009 Max. : 1.810

|  |
| --- |
| ##  ## gyros\_forearm\_y gyros\_forearm\_z accel\_forearm\_x accel\_forearm\_y  ## Min. :-5.73000 Min. :-2.58000 Min. :-328.000 Min. :-467.0  ## 1st Qu.:-1.81000 1st Qu.:-0.31000 1st Qu.:-117.000 1st Qu.: 71.0  ## Median :-0.02000 Median :-0.02000 Median : -7.000 Median : 229.0  ## Mean :-0.02303 Mean : 0.08389 Mean : -6.931 Mean : 170.6  ## 3rd Qu.: 1.78000 3rd Qu.: 0.46000 3rd Qu.: 112.000 3rd Qu.: 296.0  ## Max. : 5.17000 Max. : 2.95000 Max. : 279.000 Max. : 575.0  ##  ## accel\_forearm\_z magnet\_forearm\_x magnet\_forearm\_y magnet\_forearm\_z  ## Min. :-366.0 Min. :-1160.0 Min. :-725.0 Min. :-876.0  ## 1st Qu.:-210.0 1st Qu.: -587.2 1st Qu.: -79.5 1st Qu.: 368.0  ## Median :-181.0 Median : -329.0 Median : 653.0 Median : 558.5  ## Mean :-163.2 Mean : -347.8 Mean : 357.0 Mean : 472.8  ## 3rd Qu.:-150.0 3rd Qu.: -151.0 3rd Qu.: 747.0 3rd Qu.: 668.0  ## Max. : 239.0 Max. : 413.0 Max. :1440.0 Max. :1040.0 ##  ## classe  ## A:1365  ## B: 901  ## C: 88  ## D: 276  ## E:1370  ##  ## **dim**(training) ## [1] 4000 157 **str**(training**$**classe)  ## Factor w/ 5 levels "A","B","C","D",..: 5 5 5 5 5 5 5 5 5 5 ...  **summary**(training**$**classe)  ## A B C D E ## 1365 901 88 276 1370 **names**(testing)[**names**(testing) **!=** **names**(training)]  ## character(0) **sum**(**is.na**(training))  ## [1] 23834 **sum**(**is.na**(testing))  ## [1] 142 **names**(training) |

## [1] "user\_name" "raw\_timestamp\_part\_1"

## [3] "raw\_timestamp\_part\_2" "cvtd\_timestamp"

## [5] "new\_window" "num\_window"

## [7] "roll\_belt" "pitch\_belt"

## [9] "yaw\_belt" "total\_accel\_belt"

## [11] "kurtosis\_roll\_belt" "kurtosis\_picth\_belt"

## [13] "skewness\_roll\_belt" "skewness\_roll\_belt.1"

## [15] "max\_roll\_belt" "max\_picth\_belt"

## [17] "max\_yaw\_belt" "min\_roll\_belt"

## [19] "min\_pitch\_belt" "min\_yaw\_belt"

## [21] "amplitude\_roll\_belt" "amplitude\_pitch\_belt"

## [23] "amplitude\_yaw\_belt" "var\_total\_accel\_belt"

## [25] "avg\_roll\_belt" "stddev\_roll\_belt"

## [27] "var\_roll\_belt" "avg\_pitch\_belt"

## [29] "stddev\_pitch\_belt" "var\_pitch\_belt"

## [31] "avg\_yaw\_belt" "stddev\_yaw\_belt"

## [33] "var\_yaw\_belt" "gyros\_belt\_x"

## [35] "gyros\_belt\_y" "gyros\_belt\_z"

## [37] "accel\_belt\_x" "accel\_belt\_y"

## [39] "accel\_belt\_z" "magnet\_belt\_x"

## [41] "magnet\_belt\_y" "magnet\_belt\_z"

## [43] "roll\_arm" "pitch\_arm"

## [45] "yaw\_arm" "total\_accel\_arm"

## [47] "var\_accel\_arm" "avg\_roll\_arm"

## [49] "stddev\_roll\_arm" "var\_roll\_arm"

## [51] "avg\_pitch\_arm" "stddev\_pitch\_arm"

## [53] "var\_pitch\_arm" "avg\_yaw\_arm"

## [55] "stddev\_yaw\_arm" "var\_yaw\_arm"

## [57] "gyros\_arm\_x" "gyros\_arm\_y"

## [59] "gyros\_arm\_z" "accel\_arm\_x"

## [61] "accel\_arm\_y" "accel\_arm\_z"

## [63] "magnet\_arm\_x" "magnet\_arm\_y"

## [65] "magnet\_arm\_z" "kurtosis\_roll\_arm"

## [67] "kurtosis\_picth\_arm" "kurtosis\_yaw\_arm"

## [69] "skewness\_roll\_arm" "skewness\_pitch\_arm"

## [71] "skewness\_yaw\_arm" "max\_roll\_arm"

## [73] "max\_picth\_arm" "max\_yaw\_arm"

## [75] "min\_roll\_arm" "min\_pitch\_arm"

## [77] "min\_yaw\_arm" "amplitude\_roll\_arm"

## [79] "amplitude\_pitch\_arm" "amplitude\_yaw\_arm"

## [81] "roll\_dumbbell" "pitch\_dumbbell"

## [83] "yaw\_dumbbell" "kurtosis\_roll\_dumbbell"

## [85] "kurtosis\_picth\_dumbbell" "kurtosis\_yaw\_dumbbell"

## [87] "skewness\_roll\_dumbbell" "skewness\_pitch\_dumbbell"

## [89] "skewness\_yaw\_dumbbell" "max\_roll\_dumbbell"

## [91] "max\_picth\_dumbbell" "max\_yaw\_dumbbell"

## [93] "min\_roll\_dumbbell" "min\_pitch\_dumbbell"

## [95] "min\_yaw\_dumbbell" "amplitude\_roll\_dumbbell"

## [97] "amplitude\_pitch\_dumbbell" "amplitude\_yaw\_dumbbell"

## [99] "total\_accel\_dumbbell" "var\_accel\_dumbbell" ## [101] "avg\_roll\_dumbbell" "stddev\_roll\_dumbbell"

## [103] "var\_roll\_dumbbell" "avg\_pitch\_dumbbell"

## [105] "stddev\_pitch\_dumbbell" "var\_pitch\_dumbbell"

## [107] "avg\_yaw\_dumbbell" "stddev\_yaw\_dumbbell"

## [109] "var\_yaw\_dumbbell" "gyros\_dumbbell\_x"

## [111] "gyros\_dumbbell\_y" "gyros\_dumbbell\_z"

## [113] "accel\_dumbbell\_x" "accel\_dumbbell\_y"

## [115] "accel\_dumbbell\_z" "magnet\_dumbbell\_x"

## [117] "magnet\_dumbbell\_y" "magnet\_dumbbell\_z"

## [119] "roll\_forearm" "pitch\_forearm"

## [121] "yaw\_forearm" "kurtosis\_roll\_forearm"

## [123] "kurtosis\_picth\_forearm" "kurtosis\_yaw\_forearm"

## [125] "skewness\_roll\_forearm" "skewness\_pitch\_forearm"

## [127] "skewness\_yaw\_forearm" "max\_roll\_forearm"

## [129] "max\_picth\_forearm" "max\_yaw\_forearm"

## [131] "min\_roll\_forearm" "min\_pitch\_forearm"

## [133] "min\_yaw\_forearm" "amplitude\_roll\_forearm"

## [135] "amplitude\_pitch\_forearm" "amplitude\_yaw\_forearm"

## [137] "total\_accel\_forearm" "var\_accel\_forearm"

## [139] "avg\_roll\_forearm" "stddev\_roll\_forearm"

## [141] "var\_roll\_forearm" "avg\_pitch\_forearm"

## [143] "stddev\_pitch\_forearm" "var\_pitch\_forearm"

## [145] "avg\_yaw\_forearm" "stddev\_yaw\_forearm"

## [147] "var\_yaw\_forearm" "gyros\_forearm\_x"

## [149] "gyros\_forearm\_y" "gyros\_forearm\_z"

## [151] "accel\_forearm\_x" "accel\_forearm\_y"

## [153] "accel\_forearm\_z" "magnet\_forearm\_x"

## [155] "magnet\_forearm\_y" "magnet\_forearm\_z"

## [157] "classe"

predictorIdx <- **c**(**grep**("^accel", **names**(training)), **grep**("^gyros", **names**( train ing)),

**grep**("^magnet", **names**(training)), **grep**("^roll", **names**( train ing)), **grep**("^pitch", **names**(training)), **grep**("^yaw", **names**(training)), **grep**( "^total", **names**(training)))

trainPredSet <- training[, **c**(predictorIdx, 157)]

testPredSet <- testing[, **c**(predictorIdx, 157)] **length**(predictorIdx)

## [1] 52 **sum**(**names**(testing)[predictorIdx] **!=** **names**(training)[predictorIdx])

## [1] 0

*#sum(is.na(trainPredSet)) color = trainPredSet$classe)* **nearZeroVar**(trainPredSet[, **-**7], saveMetric = TRUE)

## freqRatio percentUnique zeroVar nzv

## accel\_belt\_x 1.027132 3.825 FALSE FALSE

## accel\_belt\_y 1.224784 2.800 FALSE FALSE

## accel\_belt\_z 1.049645 5.325 FALSE FALSE

## accel\_arm\_x 1.282353 17.650 FALSE FALSE

## accel\_arm\_y 1.129630 10.450 FALSE FALSE

## accel\_arm\_z 1.126582 16.125 FALSE FALSE

## accel\_dumbbell\_y 1.488889 9.900 FALSE FALSE

## accel\_dumbbell\_z 1.240000 6.875 FALSE FALSE

## accel\_forearm\_x 1.223881 13.000 FALSE FALSE

## accel\_forearm\_y 1.147059 20.250 FALSE FALSE

## accel\_forearm\_z 1.214286 9.225 FALSE FALSE

## gyros\_belt\_x 1.105023 3.375 FALSE FALSE

## gyros\_belt\_y 1.223844 1.250 FALSE FALSE

## gyros\_belt\_z 1.138587 2.450 FALSE FALSE

## gyros\_arm\_x 1.484375 13.550 FALSE FALSE

## gyros\_arm\_y 3.059524 7.925 FALSE FALSE

## gyros\_arm\_z 1.406977 5.300 FALSE FALSE

## gyros\_dumbbell\_x 2.088000 3.675 FALSE FALSE

## gyros\_dumbbell\_y 2.440299 6.825 FALSE FALSE

## gyros\_dumbbell\_z 1.479042 4.100 FALSE FALSE

## gyros\_forearm\_x 1.696970 5.325 FALSE FALSE

## gyros\_forearm\_y 1.011696 14.800 FALSE FALSE

## gyros\_forearm\_z 1.344156 6.750 FALSE FALSE

## magnet\_belt\_x 1.055814 6.150 FALSE FALSE

## magnet\_belt\_y 1.011429 4.650 FALSE FALSE

## magnet\_belt\_z 1.012048 9.275 FALSE FALSE

## magnet\_arm\_x 1.023810 28.675 FALSE FALSE

## magnet\_arm\_y 1.225000 20.400 FALSE FALSE

## magnet\_arm\_z 1.000000 25.925 FALSE FALSE

## magnet\_dumbbell\_x 1.673913 23.500 FALSE FALSE

## magnet\_dumbbell\_y 1.790698 18.375 FALSE FALSE

## magnet\_dumbbell\_z 2.047619 11.400 FALSE FALSE

## magnet\_forearm\_x 1.027027 23.150 FALSE FALSE

## magnet\_forearm\_y 1.085106 30.400 FALSE FALSE

## magnet\_forearm\_z 1.121212 26.875 FALSE FALSE

## roll\_belt 1.343669 21.725 FALSE FALSE

## roll\_arm 1.583333 30.850 FALSE FALSE

## roll\_dumbbell 1.487179 90.700 FALSE FALSE

## roll\_forearm 4.319444 10.725 FALSE FALSE

## pitch\_belt 1.080745 20.525 FALSE FALSE

## pitch\_arm 1.294118 42.250 FALSE FALSE

## pitch\_dumbbell 1.603448 88.725 FALSE FALSE

## pitch\_forearm 4.727273 33.900 FALSE FALSE

## yaw\_belt 1.071429 23.375 FALSE FALSE

## yaw\_arm 1.565789 41.625 FALSE FALSE

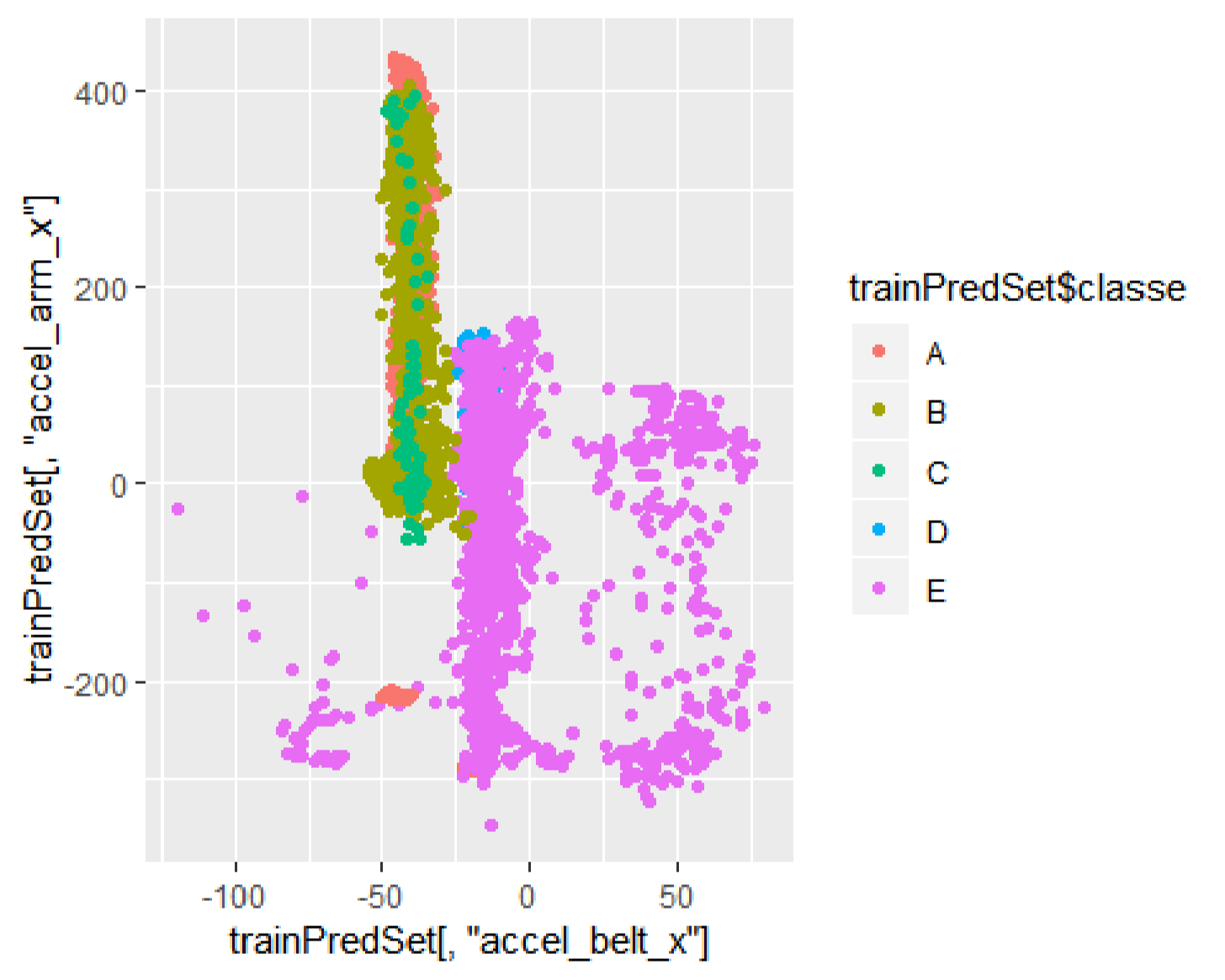
## yaw\_dumbbell 4.461538 89.450 FALSE FALSE

## yaw\_forearm 3.079208 16.500 FALSE FALSE

## total\_accel\_belt 1.260291 0.675 FALSE FALSE

## total\_accel\_arm 2.308989 1.475 FALSE FALSE ## total\_accel\_dumbbell 1.051867 0.825 FALSE FALSE

|  |
| --- |
| ## total\_accel\_forearm 1.617486 1.200 FALSE FALSE ## classe 1.003663 0.125 FALSE FALSE  **qplot**(x = trainPredSet[, "accel\_belt\_x"], y = trainPredSet[, "accel\_arm\_x"],c olor = trainPredSet**$**classe) |



|  |  |
| --- | --- |
| **set.seed**(125) | **createDataPartition**(y = trainPredSet**$**classe, p = 0.8, list = FALSE  trainPredSet[inTrain, ] trainPredSet[**-**inTrain, ]  **trainControl**(method = "repeatedcv", number = 10, repeats = 10)    (classe **~** ., data = cvTrain, method = "qda", preProcess = **c**("c  ), trControl = fitCtrl)      ## Quadratic Discriminant Analysis      ## 5 classes: 'A', 'B', 'C', 'D', 'E'  processing: centered (52), scaled (52)  -Validated (10 fold, repeated 10 times) |
| inTrain <-  )  cvTrain <- cvTest <- fitCtrl <- **set.seed**(125) modFit <- **train** enter", "scale"  **print**(modFit)  ##  ## 3201 samples  ## 52 predictor  ##  ## Pre-  ## Resampling: Cross |

## Summary of sample sizes: 2879, 2881, 2880, 2881, 2882, 2881, ...

|  |
| --- |
| ## Resampling results:  ##  ## Accuracy Kappa ## 0.9821012 0.9746877  ptrain <- **predict**(modFit, newdata = cvTrain) equalPredTrain <- (ptrain **==** cvTrain**$**classe) **print**(**sum**(equalPredTrain)**/length**(equalPredTrain))  ## [1] 0.9971884 **confusionMatrix**(data = ptrain, reference = cvTrain**$**classe)  ## Confusion Matrix and Statistics  ##  ## Reference  ## Prediction A B C D E  ## A 1088 5 0 0 0  ## B 4 716 0 0 0  ## C 0 0 71 0 0  ## D 0 0 0 221 0  ## E 0 0 0 0 1096  ##  ## Overall Statistics  ##  ## Accuracy : 0.9972  ## 95% CI : (0.9947, 0.9987)  ## No Information Rate : 0.3424  ## P-Value [Acc > NIR] : < 2.2e-16  ##  ## Kappa : 0.996 ## Mcnemar's Test P-Value : NA ##  ## Statistics by Class:  ##  ## Class: A Class: B Class: C Class: D Class: E  ## Sensitivity 0.9963 0.9931 1.00000 1.00000 1.0000  ## Specificity 0.9976 0.9984 1.00000 1.00000 1.0000  ## Pos Pred Value 0.9954 0.9944 1.00000 1.00000 1.0000  ## Neg Pred Value 0.9981 0.9980 1.00000 1.00000 1.0000  ## Prevalence 0.3411 0.2252 0.02218 0.06904 0.3424  ## Detection Rate 0.3399 0.2237 0.02218 0.06904 0.3424  ## Detection Prevalence 0.3415 0.2249 0.02218 0.06904 0.3424 ## Balanced Accuracy 0.9970 0.9957 1.00000 1.00000 1.0000  ptest <- **predict**(modFit, newdata = cvTest) equalPredTest <- (ptest **==** cvTest**$**classe) **print**(**sum**(equalPredTest)**/length**(equalPredTest))  ## [1] 0.9899875 |

|  |  |
| --- | --- |
| testPrediction <- **predict**(modFit, newdata = testing) | ))) |
| **print**(**rbind**(testing[1**:**20, 157], **as.character**( testPrediction  ## Warning in rbind(testing[1:20, 157], as.character(testPrediction)): number  ## of columns of result is not a multiple of vector length (arg 1)  ## [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]  ## [1,] "3" "3" "3" "3" "3" "3" "3" "3" "3" "3" "3" "3" "3"  ## [2,] "B" "B" "B" "B" "B" "B" "B" "B" "B" "B" "B" "B" "B"  ## [,14] [,15] [,16] [,17] [,18] [,19] [,20] [,21] [,22] [,23] [,24] ## [1,] "3" "3" "3" "3 " "3" "3" "3" "3" "3" "3" "3"  ## [2,] "B" "B" "B" "B" "B" "B" "B" "B" "B" "B" "B" |