Coursera's Practical Machine Learning

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6/10/2020

```
require(caret)
```

```
## Loading required package: caret
```

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

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

```
require(data.table)
```

```
## Loading required package: data.table
```

```
require(Rtsne)
```

```
## Loading required package: Rtsne
```

```
set.seed(1006)
```

```
# fetch the data and partition in a training set and a test set
weightLift <- fread("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv")
trainIndex <- createDataPartition(weightLift$V1, p= 0.7, list=FALSE, times=1)
df <- weightLift[trainIndex,]
test <- weightLift[-trainIndex,]
```

To get an impression of the data I look on some descriptive statistics.

```
str(df)
```

```
## Classes 'data.table' and 'data.frame':   13738 obs. of  160 variables:
##  $ V1                       : int  1 2 3 4 5 7 8 11 12 13 ...
##  $ user_name                : chr  "carlitos" "carlitos" "carlitos" "carlitos" ...
##  $ raw_timestamp_part_1     : int  1323084231 1323084231 1323084231 1323084232 1323084232 1323084232 1
##  $ raw_timestamp_part_2     : int  788290 808298 820366 120339 196328 368296 440390 500302 528316 560
##  $ cvtd_timestamp           : chr  "05/12/2011 11:23" "05/12/2011 11:23" "05/12/2011 11:23" "05/12/20
##  $ new_window               : chr  "no" "no" "no" "no" ...
##  $ num_window               : int  11 11 11 12 12 12 12 12 12 12 ...
##  $ roll_belt                : num  1.41 1.41 1.42 1.48 1.48 1.42 1.42 1.45 1.43 1.42 ...
##  $ pitch_belt               : num  8.07 8.07 8.07 8.05 8.07 8.09 8.13 8.18 8.18 8.2 ...
##  $ yaw_belt                 : num  -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 -94.4 ...
##  $ total_accel_belt         : int  3 3 3 3 3 3 3 3 3 3 ...
##  $ kurtosis_roll_belt       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_picth_belt      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_yaw_belt        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_roll_belt       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_roll_belt.1     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_yaw_belt        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_roll_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
```

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##  $ max_picth_belt          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_belt          : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_roll_belt     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_pitch_belt    : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_yaw_belt      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_total_accel_belt    : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_roll_belt        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_roll_belt           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_pitch_belt          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_pitch_belt       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_pitch_belt          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_yaw_belt         : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_yaw_belt            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ gyros_belt_x            : num  0 0.02 0 0.02 0.02 0.02 0.02 0.03 0.02 0.02 ...
##  $ gyros_belt_y            : num  0 0 0 0 0.02 0 0 0 0 0 ...
##  $ gyros_belt_z            : num  -0.02 -0.02 -0.02 -0.03 -0.02 -0.02 -0.02 -0.02 -0.02 0 ...
##  $ accel_belt_x            : int  -21 -22 -20 -22 -21 -22 -22 -21 -22 -22 ...
##  $ accel_belt_y            : int  4 4 5 3 2 3 4 2 2 4 ...
##  $ accel_belt_z            : int  22 22 23 21 24 21 21 23 23 21 ...
##  $ magnet_belt_x           : int  -3 -7 -2 -6 -6 -4 -2 -5 -2 -3 ...
##  $ magnet_belt_y           : int  599 608 600 604 600 599 603 596 602 606 ...
##  $ magnet_belt_z           : int  -313 -311 -305 -310 -302 -311 -313 -317 -319 -309 ...
##  $ roll_arm                : num  -128 -128 -128 -128 -128 -128 -128 -128 -128 -128 ...
##  $ pitch_arm               : num  22.5 22.5 22.5 22.1 22.1 21.9 21.8 21.5 21.5 21.4 ...
##  $ yaw_arm                 : num  -161 -161 -161 -161 -161 -161 -161 -161 -161 -161 ...
##  $ total_accel_arm         : int  34 34 34 34 34 34 34 34 34 34 ...
##  $ var_accel_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_roll_arm         : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_pitch_arm        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ avg_yaw_arm             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ stddev_yaw_arm          : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ var_yaw_arm             : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ gyros_arm_x             : num  0 0.02 0.02 0.02 0 0 0.02 0.02 0.02 0.02 ...
##  $ gyros_arm_y             : num  0 -0.02 -0.02 -0.03 -0.03 -0.03 -0.02 -0.03 -0.03 -0.02 ...
##  $ gyros_arm_z             : num  -0.02 -0.02 -0.02 0.02 0 0 0 0 0 -0.02 ...
##  $ accel_arm_x             : int  -288 -290 -289 -289 -289 -289 -289 -290 -288 -287 ...
##  $ accel_arm_y             : int  109 110 110 111 111 111 111 110 111 111 ...
##  $ accel_arm_z             : int  -123 -125 -126 -123 -123 -125 -124 -123 -123 -124 ...
##  $ magnet_arm_x            : int  -368 -369 -368 -372 -374 -373 -372 -366 -363 -372 ...
##  $ magnet_arm_y            : int  337 337 344 344 337 336 338 339 343 338 ...
##  $ magnet_arm_z            : int  516 513 513 512 506 509 510 509 520 509 ...
##  $ kurtosis_roll_arm       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_picth_arm      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_yaw_arm        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_roll_arm       : num  NA NA NA NA NA NA NA NA NA NA ...
```

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##  $ skewness_pitch_arm      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_yaw_arm        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_picth_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_arm             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_roll_arm            : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_arm           : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_arm             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_roll_arm      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_pitch_arm     : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_yaw_arm       : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ roll_dumbbell           : num  13.1 13.1 12.9 13.4 13.4 ...
##  $ pitch_dumbbell          : num  -70.5 -70.6 -70.3 -70.4 -70.4 ...
##  $ yaw_dumbbell            : num  -84.9 -84.7 -85.1 -84.9 -84.9 ...
##  $ kurtosis_roll_dumbbell  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_picth_dumbbell : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ kurtosis_yaw_dumbbell   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_roll_dumbbell  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_pitch_dumbbell : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ skewness_yaw_dumbbell   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_roll_dumbbell       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_picth_dumbbell      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ max_yaw_dumbbell        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_roll_dumbbell       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_pitch_dumbbell      : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ min_yaw_dumbbell        : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ amplitude_roll_dumbbell : num  NA NA NA NA NA NA NA NA NA NA ...
##   [list output truncated]
##  - attr(*, ".internal.selfref")=<externalptr>
```

```
knitr::kable(psych::describe(df))
```

	vars	n	mean	sd	median	trimmed	
V1	1	13738	9.812926e+03	5.670554e+03	9.810500e+03	9.811627e+03	7.273636e-
user_name*	2	13738	NaN	NA	NA	NaN	
raw_timestamp_part_1	3	13738	1.322828e+09	2.042933e+05	1.322833e+09	1.322836e+09	2.369995e-
raw_timestamp_part_2	4	13738	5.010279e+05	2.880743e+05	5.003090e+05	5.010904e+05	3.677523e-
cvtd_timestamp*	5	13738	NaN	NA	NA	NaN	
new_window*	6	13738	NaN	NA	NA	NaN	
num_window	7	13738	4.316962e+02	2.480595e+02	4.250000e+02	4.313626e+02	3.143112e-
roll_belt	8	13738	6.480258e+01	6.271689e+01	1.140000e+02	6.380616e+01	5.930400e-
pitch_belt	9	13738	2.224036e-01	2.237224e+01	5.280000e+00	2.350653e+00	1.076368e-
yaw_belt	10	13738	-1.067258e+01	9.531439e+01	-1.200000e+01	-2.252426e+01	1.126776e-
total_accel_belt	11	13738	1.134867e+01	7.740090e+00	1.700000e+01	1.116130e+01	1.037820e-
kurtosis_roll_belt	12	278	-1.288566e-01	3.357388e+00	-9.143300e-01	-7.325250e-01	7.412229e
kurtosis_picth_belt	13	265	4.618023e+00	1.153636e+01	-2.188700e-02	1.664773e+00	2.337399e-
kurtosis_yaw_belt	14	0	NaN	NA	NA	NaN	
skewness_roll_belt	15	279	-7.389100e-02	9.620968e-01	-1.000200e-02	-2.829630e-02	6.162709e
skewness_roll_belt.1	16	265	-2.788568e-01	2.295421e+00	-1.321770e-01	-2.437913e-01	1.452311e-
skewness_yaw_belt	17	0	NaN	NA	NA	NaN	
max_roll_belt	18	287	-2.751219e+00	9.510103e+01	-4.600000e+00	-1.279221e+01	1.232041e-
max_picth_belt	19	287	1.322997e+01	7.906097e+00	1.800000e+01	1.301299e+01	1.037820e-
max_yaw_belt	20	278	-1.276978e-01	3.356580e+00	-9.000000e-01	-7.312500e-01	7.413000e
min_roll_belt	21	287	-6.075261e+00	9.425342e+01	-7.000000e+00	-1.614026e+01	1.202389e-

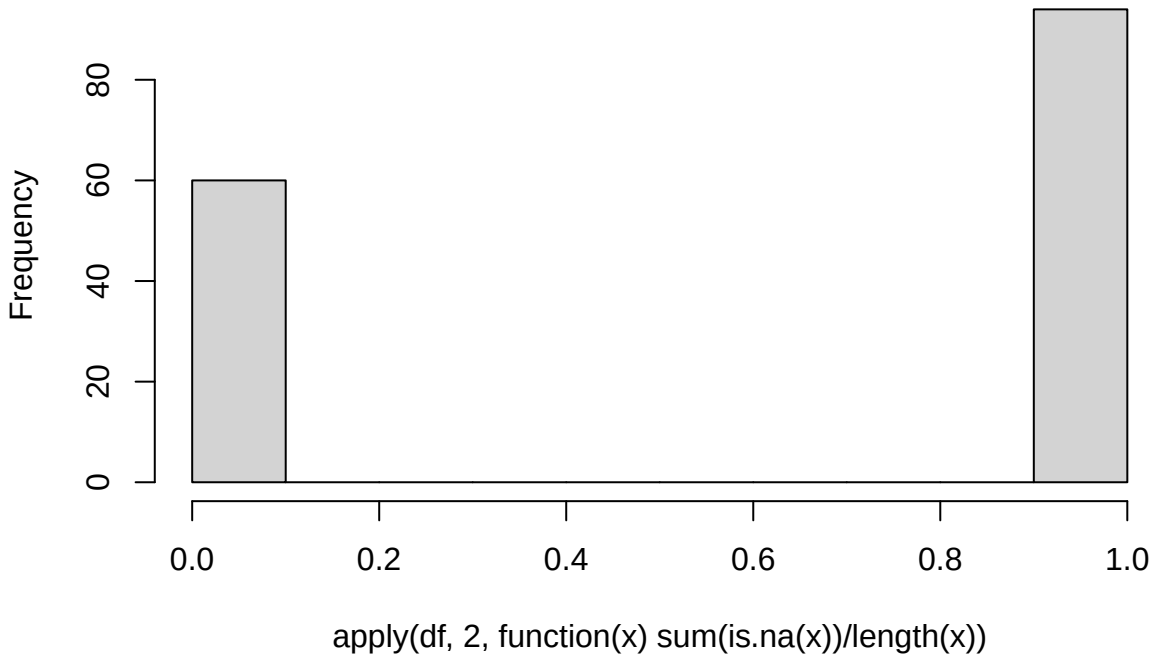
	vars	n	mean	sd	median	trimmed	
min_pitch_belt	22	287	1.105575e+01	7.423999e+00	1.700000e+01	1.124675e+01	2.965200e-
min_yaw_belt	23	278	-1.276978e-01	3.356580e+00	-9.000000e-01	-7.312500e-01	7.413000e
amplitude_roll_belt	24	287	3.323763e+00	2.133658e+01	1.000000e+00	1.476364e+00	1.186080e-
amplitude_pitch_belt	25	287	2.174216e+00	2.383869e+00	1.000000e+00	1.645022e+00	0.000000e-
amplitude_yaw_belt	26	278	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e-
var_total_accel_belt	27	287	9.312537e-01	2.306062e+00	2.000000e-01	3.006190e-01	1.482600e
avg_roll_belt	28	287	7.110962e+01	6.261504e+01	1.169000e+02	7.120890e+01	3.498936e-
stddev_roll_belt	29	287	1.336682e+00	2.431665e+00	4.000000e-01	7.226970e-01	4.447800e
var_roll_belt	30	287	7.680153e+00	2.275286e+01	2.000000e-01	1.701832e+00	2.965200e
avg_pitch_belt	31	287	-2.631710e-02	2.255390e+01	5.100000e+00	2.036778e+00	1.349166e-
stddev_pitch_belt	32	287	6.131990e-01	6.463319e-01	4.000000e-01	4.893277e-01	2.965200e
var_pitch_belt	33	287	7.882254e-01	1.808984e+00	1.000000e-01	3.662407e-01	1.482600e
avg_yaw_belt	34	287	-4.314621e+00	9.406233e+01	-5.400000e+00	-1.447587e+01	1.223145e-
stddev_yaw_belt	35	287	1.275283e+00	1.043087e+01	3.000000e-01	4.599818e-01	2.965200e
var_yaw_belt	36	287	1.100398e+02	1.840614e+03	1.100000e-01	3.955740e-01	1.630860e
gyros_belt_x	37	13738	-5.420700e-03	2.085133e-01	3.000000e-02	2.172580e-02	1.186080e
gyros_belt_y	38	13738	3.990100e-02	7.852410e-02	2.000000e-02	3.942230e-02	7.413000e
gyros_belt_z	39	13738	-1.297001e-01	2.407510e-01	-1.000000e-01	-1.194150e-01	1.482600e
accel_belt_x	40	13738	-5.431795e+00	2.970363e+01	-1.500000e+01	-7.891558e+00	1.186080e-
accel_belt_y	41	13738	3.024822e+01	2.852145e+01	3.600000e+01	2.934179e+01	4.596060e-
accel_belt_z	42	13738	-7.319639e+01	1.003599e+02	-1.530000e+02	-7.245397e+01	1.141602e-
magnet_belt_x	43	13738	5.598770e+01	6.468818e+01	3.500000e+01	4.759316e+01	3.854760e-
magnet_belt_y	44	13738	5.934914e+02	3.601126e+01	6.010000e+02	5.981754e+02	2.223900e-
magnet_belt_z	45	13738	-3.458489e+02	6.415506e+01	-3.200000e+02	-3.384369e+02	2.965200e-
roll_arm	46	13738	1.738781e+01	7.254091e+01	0.000000e+00	1.913734e+01	8.169126e-
pitch_arm	47	13738	-4.423466e+00	3.067291e+01	0.000000e+00	-5.190963e+00	2.802114e-
yaw_arm	48	13738	-6.305649e-01	7.163625e+01	0.000000e+00	3.906295e-01	6.567918e-
total_accel_arm	49	13738	2.550721e+01	1.048849e+01	2.700000e+01	2.549618e+01	1.037820e-
var_accel_arm	50	287	5.250508e+01	5.636349e+01	3.791210e+01	4.242618e+01	4.576282e-
avg_roll_arm	51	287	1.103848e+01	6.932170e+01	0.000000e+00	1.078711e+01	7.497997e-
stddev_roll_arm	52	287	1.133045e+01	1.821913e+01	5.699800e+00	7.921197e+00	7.872013e-
var_roll_arm	53	287	4.591593e+02	2.302429e+03	3.248730e+01	1.116262e+02	4.816567e-
avg_pitch_arm	54	287	-5.501464e+00	2.687920e+01	0.000000e+00	-5.975725e+00	2.449878e-
stddev_pitch_arm	55	287	1.002920e+01	8.985820e+00	8.125200e+00	8.933857e+00	1.012690e-
var_pitch_arm	56	287	1.810485e+02	2.719414e+02	6.601890e+01	1.198453e+02	9.787962e-
avg_yaw_arm	57	287	2.955971e+00	6.235935e+01	0.000000e+00	3.183480e+00	5.259271e-
stddev_yaw_arm	58	287	2.190198e+01	2.310732e+01	1.560690e+01	1.887122e+01	2.210127e-
var_yaw_arm	59	287	1.011784e+03	2.641593e+03	2.435742e+02	5.794303e+02	3.611231e-
gyros_arm_x	60	13738	4.653300e-02	1.989608e+00	8.000000e-02	1.107715e-01	2.134944e-
gyros_arm_y	61	13738	-2.594053e-01	8.509243e-01	-2.400000e-01	-2.760426e-01	7.116480e
gyros_arm_z	62	13738	2.706813e-01	5.504081e-01	2.300000e-01	2.834398e-01	5.782140e
accel_arm_x	63	13738	-6.092503e+01	1.825116e+02	-4.600000e+01	-7.214147e+01	2.461116e-
accel_arm_y	64	13738	3.265315e+01	1.099842e+02	1.400000e+01	3.233070e+01	1.363992e-
accel_arm_z	65	13738	-7.039154e+01	1.337761e+02	-4.600000e+01	-5.890766e+01	1.171254e-
magnet_arm_x	66	13738	1.902753e+02	4.438397e+02	2.880000e+02	1.985159e+02	6.241746e-
magnet_arm_y	67	13738	1.582494e+02	2.011452e+02	2.040000e+02	1.695567e+02	2.075640e-
magnet_arm_z	68	13738	3.082572e+02	3.252208e+02	4.440000e+02	3.579159e+02	1.942206e-
kurtosis_roll_arm	69	235	-3.783619e-01	1.886589e+00	-8.546700e-01	-6.582585e-01	8.937854e
kurtosis_picth_arm	70	233	-5.439761e-01	1.442643e+00	-9.691200e-01	-8.215856e-01	6.252865e
kurtosis_yaw_arm	71	278	4.075700e-03	3.485325e+00	-7.390650e-01	-5.579420e-01	8.272167e
skewness_roll_arm	72	236	5.501570e-02	8.920562e-01	3.735500e-02	5.940190e-02	9.387971e
skewness_pitch_arm	73	233	-6.417820e-02	8.160239e-01	-1.106800e-01	-1.013405e-01	8.120200e

	vars	n	mean	sd	median	trimmed	
skewness_yaw_arm	74	278	-2.455000e-01	9.964374e-01	-1.458750e-01	-2.007666e-01	7.668007e
max_roll_arm	75	287	1.007143e+01	2.649587e+01	4.400000e+00	9.253680e+00	1.957032e-
max_picth_arm	76	287	3.540592e+01	6.911166e+01	2.380000e+01	3.694632e+01	6.968220e-
max_yaw_arm	77	287	3.547387e+01	1.055349e+01	3.400000e+01	3.527273e+01	8.895600e-
min_roll_arm	78	287	-2.157909e+01	2.876584e+01	-2.210000e+01	-2.161558e+01	3.276546e-
min_pitch_arm	79	287	-3.397073e+01	6.282845e+01	-3.360000e+01	-3.552987e+01	4.981536e-
min_yaw_arm	80	287	1.483275e+01	8.968081e+00	1.300000e+01	1.391775e+01	8.895600e-
amplitude_roll_arm	81	287	3.164927e+01	2.626027e+01	2.830000e+01	2.899961e+01	3.224655e-
amplitude_pitch_arm	82	287	6.937700e+01	6.660135e+01	5.390000e+01	6.142294e+01	7.546434e-
amplitude_yaw_arm	83	287	2.064111e+01	1.229049e+01	2.100000e+01	2.038095e+01	1.186080e-
roll_dumbbell	84	13738	2.337318e+01	6.983146e+01	4.787571e+01	2.886744e+01	5.432288e-
pitch_dumbbell	85	13738	-1.105792e+01	3.682272e+01	-2.136206e+01	-1.344304e+01	4.170524e-
yaw_dumbbell	86	13738	1.619391e+00	8.265640e+01	-4.401130e+00	-1.185427e+00	1.117658e-
kurtosis_roll_dumbbell	87	284	2.650690e-01	1.579976e+00	-3.130000e-02	5.041450e-02	1.118251e-
kurtosis_picth_dumbbell	88	286	1.316409e-01	1.960465e+00	-1.516500e-01	-1.287139e-01	9.284782e
kurtosis_yaw_dumbbell	89	0	NaN	NA	NA	NaN	
skewness_roll_dumbbell	90	285	-6.615020e-02	7.197314e-01	-6.490000e-02	-6.494760e-02	7.448582e
skewness_pitch_dumbbell	91	287	1.951900e-03	7.692550e-01	-5.870000e-02	-1.390560e-02	7.392244e
skewness_yaw_dumbbell	92	0	NaN	NA	NA	NaN	
max_roll_dumbbell	93	287	1.365087e+01	4.851680e+01	1.230000e+01	1.078009e+01	5.782140e-
max_picth_dumbbell	94	287	3.224042e+01	9.247929e+01	3.640000e+01	3.322597e+01	1.461844e-
max_yaw_dumbbell	95	284	2.637324e-01	1.580241e+00	0.000000e+00	5.000000e-02	1.186080e-
min_roll_dumbbell	96	287	-4.011707e+01	3.538785e+01	-4.240000e+01	-3.964545e+01	2.564898e-
min_pitch_dumbbell	97	287	-3.241080e+01	7.532547e+01	-6.540000e+01	-3.791645e+01	6.686526e-
min_yaw_dumbbell	98	284	2.637324e-01	1.580241e+00	0.000000e+00	5.000000e-02	1.186080e-
amplitude_roll_dumbbell	99	287	5.376885e+01	5.477298e+01	3.332000e+01	4.440641e+01	3.495971e-
amplitude_pitch_dumbbell	100	287	6.465108e+01	6.442036e+01	4.176000e+01	5.408766e+01	4.320296e-
amplitude_yaw_dumbbell	101	284	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e-
total_accel_dumbbell	102	13738	1.372864e+01	1.023054e+01	1.000000e+01	1.292358e+01	1.037820e-
var_accel_dumbbell	103	287	3.907758e+00	7.928357e+00	9.663000e-01	1.913439e+00	1.133596e-
avg_roll_dumbbell	104	287	2.233106e+01	6.383293e+01	4.698740e+01	2.733214e+01	4.682407e-
stddev_roll_dumbbell	105	287	1.951787e+01	2.261315e+01	1.209090e+01	1.479689e+01	1.284213e-
var_roll_dumbbell	106	287	8.905203e+02	2.015552e+03	1.461887e+02	3.449482e+02	2.088628e-
avg_pitch_dumbbell	107	287	-1.237730e+01	3.269601e+01	-2.133730e+01	-1.430796e+01	3.867911e-
stddev_pitch_dumbbell	108	287	1.278882e+01	1.310290e+01	7.955200e+00	1.062341e+01	8.063120e-
var_pitch_dumbbell	109	287	3.346414e+02	6.771033e+02	6.328550e+01	1.776526e+02	9.099754e-
avg_yaw_dumbbell	110	287	3.707338e-01	7.845592e+01	-4.676900e+00	-2.198229e+00	1.080771e-
stddev_yaw_dumbbell	111	287	1.638919e+01	1.790185e+01	9.800100e+00	1.320950e+01	1.057287e-
var_yaw_dumbbell	112	287	5.879652e+02	1.342401e+03	9.604130e+01	2.776658e+02	1.374303e-
gyros_dumbbell_x	113	13738	1.540013e-01	1.785099e+00	1.300000e-01	1.576255e-01	2.816940e
gyros_dumbbell_y	114	13738	4.979040e-02	6.532407e-01	5.000000e-02	3.885190e-02	2.668680e
gyros_dumbbell_z	115	13738	-1.217200e-01	2.724595e+00	-1.300000e-01	-1.356214e-01	2.520420e
accel_dumbbell_x	116	13738	-2.890100e+01	6.720112e+01	-9.000000e+00	-2.510335e+01	4.744320e-
accel_dumbbell_y	117	13738	5.241469e+01	8.076612e+01	4.200000e+01	4.910872e+01	8.302560e-
accel_dumbbell_z	118	13738	-3.857519e+01	1.095693e+02	-1.000000e+00	-3.625664e+01	1.215732e-
magnet_dumbbell_x	119	13738	-3.295427e+02	3.393138e+02	-4.800000e+02	-4.033840e+02	1.082298e-
magnet_dumbbell_y	120	13738	2.208057e+02	3.269292e+02	3.110000e+02	2.806364e+02	1.171254e-
magnet_dumbbell_z	121	13738	4.551482e+01	1.398553e+02	1.300000e+01	3.223168e+01	1.008168e-
roll_forearm	122	13738	3.379717e+01	1.075955e+02	2.185000e+01	4.220156e+01	1.410694e-
pitch_forearm	123	13738	1.065575e+01	2.812550e+01	9.180000e+00	1.235336e+01	1.759105e-
yaw_forearm	124	13738	1.885091e+01	1.032526e+02	0.000000e+00	2.262898e+01	1.448500e-
kurtosis_roll_forearm	125	224	-8.421379e-01	9.283679e-01	-1.119500e+00	-1.002517e+00	5.295847e

	vars	n	mean	sd	median	trimmed	r
kurtosis_picth_forearm	126	224	4.133741e-01	4.196372e+00	-9.022000e-01	-5.209067e-01	9.969744e
kurtosis_yaw_forearm	127	0	NaN	NA	NA	NaN	
skewness_roll_forearm	128	225	-1.698700e-03	6.375018e-01	8.950000e-02	2.362930e-02	5.636845e
skewness_pitch_forearm	129	224	-1.818790e-01	1.237083e+00	-1.539000e-01	-1.374189e-01	1.077183e-
skewness_yaw_forearm	130	0	NaN	NA	NA	NaN	
max_roll_forearm	131	287	2.469965e+01	3.085406e+01	2.610000e+01	2.614589e+01	3.780630e-
max_picth_forearm	132	287	8.042578e+01	9.615895e+01	1.130000e+02	8.963377e+01	9.785160e-
max_yaw_forearm	133	224	-8.410714e-01	9.317570e-01	-1.100000e+00	-1.002222e+00	5.930400e
min_roll_forearm	134	287	2.787500e-03	2.220249e+01	0.000000e+00	1.849351e+00	1.230558e-
min_pitch_forearm	135	287	-5.938606e+01	1.088289e+02	-6.220000e+01	-6.788831e+01	1.627895e-
min_yaw_forearm	136	224	-8.410714e-01	9.317570e-01	-1.100000e+00	-1.002222e+00	5.930400e
amplitude_roll_forearm	137	287	2.469683e+01	2.503984e+01	1.880000e+01	2.125377e+01	2.787288e-
amplitude_pitch_forearm	138	287	1.398116e+02	1.473481e+02	8.550000e+01	1.303460e+02	1.267623e-
amplitude_yaw_forearm	139	224	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e-
total_accel_forearm	140	13738	3.467754e+01	1.006288e+01	3.600000e+01	3.518559e+01	8.895600e-
var_accel_forearm	141	287	3.386779e+01	3.418706e+01	2.282221e+01	2.883196e+01	2.767437e-
avg_roll_forearm	142	287	3.217544e+01	7.949569e+01	4.545920e+00	3.417134e+01	6.655947e-
stddev_roll_forearm	143	287	4.126155e+01	5.908794e+01	7.198270e+00	3.165831e+01	1.067216e-
var_roll_forearm	144	287	5.181734e+03	9.115154e+03	5.181511e+01	3.257329e+03	7.682108e-
avg_pitch_forearm	145	287	1.175059e+01	2.474425e+01	1.178348e+01	1.322653e+01	1.747019e-
stddev_pitch_forearm	146	287	7.934969e+00	8.394237e+00	5.697590e+00	6.743361e+00	8.447247e-
var_pitch_forearm	147	287	1.331814e+02	2.402166e+02	3.246255e+01	8.049219e+01	4.812898e-
avg_yaw_forearm	148	287	1.589409e+01	7.779088e+01	0.000000e+00	1.712870e+01	9.195297e-
stddev_yaw_forearm	149	287	4.463291e+01	5.082577e+01	2.438293e+01	3.781645e+01	3.615013e-
var_yaw_forearm	150	287	4.566355e+03	7.221623e+03	5.945273e+02	3.079350e+03	8.814462e-
gyros_forearm_x	151	13738	1.594694e-01	6.571596e-01	5.000000e-02	1.487627e-01	5.337360e
gyros_forearm_y	152	13738	8.496800e-02	3.422890e+00	3.000000e-02	9.636550e-02	2.298030e-
gyros_forearm_z	153	13738	1.567601e-01	2.058335e+00	8.000000e-02	1.338828e-01	5.040840e
accel_forearm_x	154	13738	-6.189875e+01	1.802398e+02	-5.700000e+01	-5.564520e+01	1.882902e-
accel_forearm_y	155	13738	1.640539e+02	1.996647e+02	2.000000e+02	1.794622e+02	1.793946e-
accel_forearm_z	156	13738	-5.528818e+01	1.381170e+02	-3.900000e+01	-6.532269e+01	1.853250e-
magnet_forearm_x	157	13738	-3.133810e+02	3.469673e+02	-3.790000e+02	-3.460801e+02	3.854760e-
magnet_forearm_y	158	13738	3.818310e+02	5.088517e+02	5.930000e+02	4.284647e+02	2.802114e-
magnet_forearm_z	159	13738	3.946678e+02	3.691069e+02	5.120000e+02	4.475838e+02	2.431464e-
classe*	160	13738	NaN	NA	NA	NaN	

```
# preprocessing, removing columns with NA
sel <- !apply(df,2,function(x) all(is.na(x)))
df<- data.table(as.data.frame(df)[,sel])

hist(apply(df,2, function(x) sum(is.na(x))/length(x)))
```




```
#modelRF <- train(classe~., data =df, method="rf")
```