Study Design and Code Book.

Reference Site for understanding the data better:
https://www.elen.ucl.ac.be/Proceedings/esann/esannpdf/es2013-84.pdf
https://sites.google.com/site/harsmartlab/

Values in Final tidy dataset :
180 obs. of 88 variables:
 $ obsID : Factor w/ 30 levels "1","10","11",..: 1 1 1 1 1 1 2 2 2 2 ...
The obdID belongs to the SUBJECT ID

 $ obsActivity_str : chr "LAYING" "SITTING" "STANDING" "WALKING" ...
The obsActivity_str is the activity ID

We have 86 factors whose average has been calculated per subject ID and per activity :
eg : We can retrieve the value of meantBodyGyro.mean for Subject 1 and Activity say "STANDING" by a select operation

 $ tBodyAcc.mean...X : num 0.222 0.261 0.279 0.277 0.289 ...
 $ tBodyAcc.mean...Y : num -0.04051 -0.00131 -0.01614 -0.01738 -0.00992 ...
 $ tBodyAcc.mean...Z : num -0.113 -0.105 -0.111 -0.111 -0.108 ...
 $ tGravityAcc.mean...X : num -0.249 0.832 0.943 0.935 0.932 ...
 $ tGravityAcc.mean...Y : num 0.706 0.204 -0.273 -0.282 -0.267 ...
 $ tGravityAcc.mean...Z : num 0.4458 0.332 0.0135 -0.0681 -0.0621 ...
 $ tBodyAccJerk.mean...X : num 0.0811 0.0775 0.0754 0.074 0.0542 ...
 $ tBodyAccJerk.mean...Y : num 0.003838 -0.000619 0.007976 0.028272 0.02965 ...
 $ tBodyAccJerk.mean...Z : num 0.01083 -0.00337 -0.00369 -0.00417 -0.01097 ...
 $ tBodyGyro.mean...X : num -0.0166 -0.0454 -0.024 -0.0418 -0.0351 ...
 $ tBodyGyro.mean...Y : num -0.0645 -0.0919 -0.0594 -0.0695 -0.0909 ...
 $ tBodyGyro.mean...Z : num 0.1487 0.0629 0.0748 0.0849 0.0901 ...
 $ tBodyGyroJerk.mean...X : num -0.1073 -0.0937 -0.0996 -0.09 -0.074 ...
 $ tBodyGyroJerk.mean...Y : num -0.0415 -0.0402 -0.0441 -0.0398 -0.044 ...
 $ tBodyGyroJerk.mean...Z : num -0.0741 -0.0467 -0.049 -0.0461 -0.027 ...
 $ tBodyAccMag.mean.. : num -0.8419 -0.9485 -0.9843 -0.137 0.0272 ...
 $ tGravityAccMag.mean.. : num -0.8419 -0.9485 -0.9843 -0.137 0.0272 ...
 $ tBodyAccJerkMag.mean.. : num -0.9544 -0.9874 -0.9924 -0.1414 -0.0894 ...
 $ tBodyGyroMag.mean.. : num -0.8748 -0.9309 -0.9765 -0.161 -0.0757 ...
 $ tBodyGyroJerkMag.mean.. : num -0.963 -0.992 -0.995 -0.299 -0.295 ...
 $ fBodyAcc.mean...X : num -0.9391 -0.9796 -0.9952 -0.2028 0.0382 ...
 $ fBodyAcc.mean...Y : num -0.86707 -0.94408 -0.97707 0.08971 0.00155 ...
 $ fBodyAcc.mean...Z : num -0.883 -0.959 -0.985 -0.332 -0.226 ...
 $ fBodyAcc.meanFreq...X : num -0.1588 -0.0495 0.0865 -0.2075 -0.3074 ...
 $ fBodyAcc.meanFreq...Y : num 0.0975 0.0759 0.1175 0.1131 0.0632 ...
 $ fBodyAcc.meanFreq...Z : num 0.0894 0.2388 0.2449 0.0497 0.2943 ...
 $ fBodyAccJerk.mean...X : num -0.9571 -0.9866 -0.9946 -0.1705 -0.0277 ...
 $ fBodyAccJerk.mean...Y : num -0.9225 -0.9816 -0.9854 -0.0352 -0.1287 ...
 $ fBodyAccJerk.mean...Z : num -0.948 -0.986 -0.991 -0.469 -0.288 ...
 $ fBodyAccJerk.meanFreq...X : num 0.132 0.257 0.314 -0.209 -0.253 ...
 $ fBodyAccJerk.meanFreq...Y : num 0.0245 0.0475 0.0392 -0.3862 -0.3376 ...
 $ fBodyAccJerk.meanFreq...Z : num 0.02439 0.09239 0.13858 -0.18553 0.00937 ...
 $ fBodyGyro.mean...X : num -0.85 -0.976 -0.986 -0.339 -0.352 ...
 $ fBodyGyro.mean...Y : num -0.9522 -0.9758 -0.989 -0.1031 -0.0557 ...
 $ fBodyGyro.mean...Z : num -0.9093 -0.9513 -0.9808 -0.2559 -0.0319 ...
 $ fBodyGyro.meanFreq...X : num -0.00355 0.18915 -0.12029 0.01478 -0.10045 ...
 $ fBodyGyro.meanFreq...Y : num -0.0915 0.0631 -0.0447 -0.0658 0.0826 ...
 $ fBodyGyro.meanFreq...Z : num 0.010458 -0.029784 0.100608 0.000773 -0.075676 ...
 $ fBodyAccMag.mean.. : num -0.8618 -0.9478 -0.9854 -0.1286 0.0966 ...

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$ fBodyAccMag.meanFreq..              : num  0.0864 0.2367 0.2846 0.1906 0.1192 ...
$ fBodyBodyAccJerkMag.mean..          : num  -0.9333 -0.9853 -0.9925 -0.0571 0.0262 ...
$ fBodyBodyAccJerkMag.meanFreq..      : num  0.2664 0.3519 0.4222 0.0938 0.0765 ...
$ fBodyBodyGyroMag.mean..             : num  -0.862 -0.958 -0.985 -0.199 -0.186 ...
$ fBodyBodyGyroMag.meanFreq..         : num  -0.139775 -0.000262 -0.028606 0.268844 0.349614 ...
$ fBodyBodyGyroJerkMag.mean..         : num  -0.942 -0.99 -0.995 -0.319 -0.282 ...
$ fBodyBodyGyroJerkMag.meanFreq..     : num  0.176 0.185 0.334 0.191 0.19 ...
$ angle.tBodyAccMean.gravity.         : num  0.021366 0.027442 -0.000222 0.060454 -0.002695 ...
$ angle.tBodyAccJerkMean..gravityMean.: num  0.00306 0.02971 0.02196 -0.00793 0.08993 ...
$ angle.tBodyGyroMean.gravityMean.    : num  -0.00167 0.0677 -0.03379 0.01306 0.06334 ...
$ angle.tBodyGyroJerkMean.gravityMean.: num  0.0844 -0.0649 -0.0279 -0.0187 -0.04 ...
$ angle.X.gravityMean.                : num  0.427 -0.591 -0.743 -0.729 -0.744 ...
$ angle.Y.gravityMean.                : num  -0.5203 -0.0605 0.2702 0.277 0.2672 ...
$ angle.Z.gravityMean.                : num  -0.3524 -0.218 0.0123 0.0689 0.065 ...
$ tBodyAcc.std...X                    : num  -0.928 -0.977 -0.996 -0.284 0.03 ...
$ tBodyAcc.std...Y                    : num  -0.8368 -0.9226 -0.9732 0.1145 -0.0319 ...
$ tBodyAcc.std...Z                    : num  -0.826 -0.94 -0.98 -0.26 -0.23 ...
$ tGravityAcc.std...X                 : num  -0.897 -0.968 -0.994 -0.977 -0.951 ...
$ tGravityAcc.std...Y                 : num  -0.908 -0.936 -0.981 -0.971 -0.937 ...
$ tGravityAcc.std...Z                 : num  -0.852 -0.949 -0.976 -0.948 -0.896 ...
$ tBodyAccJerk.std...X                : num  -0.9585 -0.9864 -0.9946 -0.1136 -0.0123 ...
$ tBodyAccJerk.std...Y                : num  -0.924 -0.981 -0.986 0.067 -0.102 ...
$ tBodyAccJerk.std...Z                : num  -0.955 -0.988 -0.992 -0.503 -0.346 ...
$ tBodyGyro.std...X                   : num  -0.874 -0.977 -0.987 -0.474 -0.458 ...
$ tBodyGyro.std...Y                   : num  -0.9511 -0.9665 -0.9877 -0.0546 -0.1263 ...
$ tBodyGyro.std...Z                   : num  -0.908 -0.941 -0.981 -0.344 -0.125 ...
$ tBodyGyroJerk.std...X               : num  -0.919 -0.992 -0.993 -0.207 -0.487 ...
$ tBodyGyroJerk.std...Y               : num  -0.968 -0.99 -0.995 -0.304 -0.239 ...
$ tBodyGyroJerk.std...Z               : num  -0.958 -0.988 -0.992 -0.404 -0.269 ...
$ tBodyAccMag.std..                   : num  -0.7951 -0.9271 -0.9819 -0.2197 0.0199 ...
$ tGravityAccMag.std..                : num  -0.7951 -0.9271 -0.9819 -0.2197 0.0199 ...
$ tBodyAccJerkMag.std..               : num  -0.9282 -0.9841 -0.9931 -0.0745 -0.0258 ...
$ tBodyGyroMag.std..                  : num  -0.819 -0.935 -0.979 -0.187 -0.226 ...
$ tBodyGyroJerkMag.std..              : num  -0.936 -0.988 -0.995 -0.325 -0.307 ...
$ fBodyAcc.std...X                    : num  -0.9244 -0.9764 -0.996 -0.3191 0.0243 ...
$ fBodyAcc.std...Y                    : num  -0.834 -0.917 -0.972 0.056 -0.113 ...
$ fBodyAcc.std...Z                    : num  -0.813 -0.934 -0.978 -0.28 -0.298 ...
$ fBodyAccJerk.std...X                : num  -0.9642 -0.9875 -0.9951 -0.1336 -0.0863 ...
$ fBodyAccJerk.std...Y                : num  -0.932 -0.983 -0.987 0.107 -0.135 ...
$ fBodyAccJerk.std...Z                : num  -0.961 -0.988 -0.992 -0.535 -0.402 ...
$ fBodyGyro.std...X                   : num  -0.882 -0.978 -0.987 -0.517 -0.495 ...
$ fBodyGyro.std...Y                   : num  -0.9512 -0.9623 -0.9871 -0.0335 -0.1814 ...
$ fBodyGyro.std...Z                   : num  -0.917 -0.944 -0.982 -0.437 -0.238 ...
$ fBodyAccMag.std..                   : num  -0.798 -0.928 -0.982 -0.398 -0.187 ...
$ fBodyBodyAccJerkMag.std..           : num  -0.922 -0.982 -0.993 -0.103 -0.104 ...
$ fBodyBodyGyroMag.std..              : num  -0.824 -0.932 -0.978 -0.321 -0.398 ...
$ fBodyBodyGyroJerkMag.std..          : num  -0.933 -0.987 -0.995 -0.382 -0.392 ...
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Feature Selection
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The features selected for this database come from the accelerometer and gyroscope 3-axial raw signals tAcc-XYZ and tGyro-XYZ. These time domain signals (prefix 't' to denote time) were captured at a constant rate of 50 Hz. Then they were filtered using a median filter and a 3rd order low pass Butterworth filter with a corner frequency of 20 Hz to remove noise. Similarly, the acceleration signal was then separated into body and gravity acceleration signals (tBodyAcc-XYZ and tGravityAcc-XYZ) using another low pass Butterworth filter with a corner frequency of 0.3 Hz.

Subsequently, the body linear acceleration and angular velocity were derived in time to obtain Jerk signals (tBodyAccJerk-XYZ and tBodyGyroJerk-XYZ). Also the magnitude of these three-dimensional signals were calculated using the Euclidean norm (tBodyAccMag, tGravityAccMag, tBodyAccJerkMag, tBodyGyroMag, tBodyGyroJerkMag).

Finally a Fast Fourier Transform (FFT) was applied to some of these signals producing fBodyAcc-XYZ, fBodyAccJerk-XYZ, fBodyGyro-XYZ, fBodyAccJerkMag, fBodyGyroMag, fBodyGyroJerkMag. (Note the 'f' to indicate frequency domain signals).

These signals were used to estimate variables of the feature vector for each pattern:
'-XYZ' is used to denote 3-axial signals in the X, Y and Z directions.

tBodyAcc-XYZ
tGravityAcc-XYZ
tBodyAccJerk-XYZ
tBodyGyro-XYZ
tBodyGyroJerk-XYZ
tBodyAccMag
tGravityAccMag
tBodyAccJerkMag
tBodyGyroMag
tBodyGyroJerkMag
fBodyAcc-XYZ
fBodyAccJerk-XYZ
fBodyGyro-XYZ
fBodyAccMag
fBodyAccJerkMag
fBodyGyroMag
fBodyGyroJerkMag

The set of variables that were estimated from these signals are:

mean(): Mean value
std(): Standard deviation
mad(): Median absolute deviation
max(): Largest value in array
min(): Smallest value in array
sma(): Signal magnitude area
energy(): Energy measure. Sum of the squares divided by the number of values.
iqr(): Interquartile range
entropy(): Signal entropy
arCoeff(): Autorregresion coefficients with Burg order equal to 4
correlation(): correlation coefficient between two signals
maxInds(): index of the frequency component with largest magnitude
meanFreq(): Weighted average of the frequency components to obtain a mean frequency
skewness(): skewness of the frequency domain signal
kurtosis(): kurtosis of the frequency domain signal
bandsEnergy(): Energy of a frequency interval within the 64 bins of the FFT of each window.
angle(): Angle between to vectors.

Additional vectors obtained by averaging the signals in a signal window sample. These are used on the angle() variable:

gravityMean
tBodyAccMean
tBodyAccJerkMean
tBodyGyroMean
tBodyGyroJerkMean

The complete list of variables of each feature vector is available in 'features.txt'