Workflow

# Data Import

Get raw data from instrument acquisition and convert into MATLAB-readable data.

# Data Pre-Processing and Descriptive Statistics

Smooth noisy time series using a moving average filter and compute frequency spectra for the frequencies of interest. In particular, filter out spectral components higher than .

Produce plots to show time and frequency trends for accelerations from:

* different days
* different velocities
* different sets of acquisitions
* different load conditions (no-load vs load operations)

# Feature Extraction

Compute time-domain and frequency-domain signal features and select relevant ones.  
Create training and test datasets to be passed to the Classification Model or the Neural Network.

Perform this analysis using only no-load vibrations and later using load vibrations too. Combine data into a single dataset to perform both a *single-step prediction* of the 10 possible combinations of working conditions and a *double-step classification*, first distinguishing between load and no-load operations and then extracting the velocity values.

# Classifier Prediction

Evaluate test data to assess prediction performance obtained using a Traditional Classifier (KNN, SVM, TREES, etc.). Produce accuracy plot and confusion matrix.

# Neural Network Prediction

Evaluate test data to assess prediction performance obtained using a LSTM Neural Network.  
Produce accuracy plot and confusion matrix.

This section only performs a preliminary analysis. For full coverage, see src >> LSTM\_Classifier.

# Accuracy Evaluation – Bootstrapping

Perform bootstrapping to determine mean accuracy value and confidence interval of this estimate for the prediction algorithm. This operation is performed both on *single-step classification* and *double-step classification*.

# Velocity Regression

Regression model to predict continuous velocity values. This analysis is performed separately taking into account respectively data related to under-load and no-load operations.

# Force Estimation

Evaluation of the mean force measured during all acquisitions. Extract a single value to be associated to each velocity value.

Different models are fitted to force data in order to find a plausible empirical relationship, but no physically solid explanation and modelling have been achieved.

PLEASE NOTE:

* Code for points from 3 to 6 is located under src >> KNN\_Classifier.
* The same steps are performed for the LSTM Neural Network approach and related files are located under src >> LSTM\_Classifier. Names are slightly different, but the workflow is similar.