# DATA INFORMATION

- The dataset includes triaxial vibration data of bearing of induction motor operated under different load conditions along the axes x, y, and z.

- It includes triaxial vibration datasets of motor in healthy condition with and without pulley. The faulty conditions of bearings include inner race and outer race faults of (i) 0.7mm, (i) 0.9mm, (i) 1.1mm, (i) 1.3mm, (i) 1.5m, and (i) 1.7mm.

- The bearings with these fault severity levels were operated under different load conditions including 100W, 200W, and 300W. There are in total 38 datasets of the bearing conditions.

- The data was acquired at the sampling rate of 10 kHz at the rate of 1000 samples per channel.

## DATA IMPORTING AND PLOTTING

- First processed data is the vibration measurement of motor in healthy condition without pulley. Name: DATA\_HEALTY\_NOPULLEY

- Second processed data is the vibration measurement of motor in healthy condition with pulley. Name: DATA\_HEALTY\_PULLEY

## COMPUTE OF MEAN, RMS AND STANDARD DEVIATION

- The RMS value of the vibration signal in this case is important because it provides a measure of the amplitude of the vibration signal. The RMS value can also help determine if the vibration levels are within acceptable limits.

- The standard deviation and mean values are important because they provide a measure of the stability and consistency of the vibration signal over time. A stable and consistent vibration signal is indicative of well-functioning machinery or equipment, while deviations from the baseline can indicate potential problems or faults.

## CONVERTION FROM TIME TO FREQUENCY DOMAIN

- When analyzing vibration signals as a function of time, which can reveal information about the amplitude, waveform, and timing of the vibration, but this representation can be limited in its ability to identify the specific frequencies that are contributing to the vibration

- For this reason, the data will be converted from the time domain to the frequency domain using the Fourier transform mathematical technique, to characterize the frequencies of the vibration signal

- This will allow us to identify specific frequencies and harmonics that may be contributing to the overall vibration, as well as any resonant frequencies, vibration modes or other patterns in the vibration signal that may indicate a fault or issue with the bearing.

-Also, the frequency domain representation simplifies the analysis of vibration data by allowing to apply filters to reduce the amount of noise and other unwanted components that may be present in the time domain. This makes easier to identify patterns and frequencies in the signal, allowing us to make more accurate diagnoses and predictions about the health of the machinery.

## RMS MEAN AND STD DEVIATION CALCULATION ON FREQUENCY DOMAIN

- We are now going to calculate RMS, mean and standard deviation from vibration data to obtain information about the characteristics of the vibration signal.

- The RMS value is a measure of the overall amplitude or energy of the vibration signal in a given frequency range and can be used to assess the severity of vibration and compare it to acceptable levels or standards. The RMS value can also be used to identify any changes in the vibration level over time, which can help with predictive maintenance and early detection of potential issues.

- The mean value in the frequency domain represents the average value of the signal over a given frequency range. It can be useful for identifying the dominant frequency components of the signal, as well as any trends or changes in the frequency content over time.

- The standard deviation (STD) in the frequency domain represents the variability of the signal around the mean value. It can be useful in identifying any unusual or unexpected patterns or fluctuations in the vibration signal, which may indicate a fault or issue with the machinery.

## MACHINE LEARNING FOR VIBRATION ANALYSIS

- At this part we will start the development of the ML model to identify possible failures. When training a decision tree model for vibration analysis in bearings, we are trying to build a model that can learn to distinguish between healthy and faulty bearings based on the patterns it observes in the data.

- The reason why we can train a decision tree model for vibration analysis in bearings is to provide early detection of faults, improve maintenance planning, increase equipment lifespan, reduce energy consumption, and enhance safety, among other benefits. These physical results can translate into cost savings, increased productivity, and improved operational efficiency for the machinery and the organization.

- There are several reasons why using a decision tree model for vibration analysis in bearings can be better than using other models:

1- Interpretable: Decision tree models are highly interpretable, which means that they are easy to understand and explain. This is particularly useful in the context of vibration analysis in bearings, where it is important to have a clear understanding of the factors that contribute to the detection of faults.

2- Non-linear: Decision tree models can capture non-linear relationships between the input features and the output variable. In the case of vibration analysis in bearings, there may be complex and non-linear relationships between the vibration data and the health of the bearings.

3- Robust: Decision tree models are robust to outliers and missing data, which is important in real-world applications where data quality may be poor.

4- Scalable: Decision tree models are scalable and can handle large datasets with many features. This is important in the context of vibration analysis in bearings, where there may be many different features that need to be considered.

5- Easy to Implement: Decision tree models are easy to implement and require minimal pre-processing of the data. This makes them an attractive choice for practitioners who want to quickly build and deploy a model for vibration analysis in bearings.

At the same time, other models will be trained in order to compare them against the decision tree model and to check which one fits best to the data and provides a more accurate response to the bearing’s behavior.