Universidade Estadual Paulista - UNESP
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Introduction to Structural Health Monitoring (SHM)
Homework 1 - Statistical Classification using Mahalanobis Distance

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Assume a single degree of freedom mechanical system with a linear spring of $k = 1000$ N/m and mass of $m = 1$ kg. Compute:

1. Generate many output vibration data for the healthy condition and assume reduced stiffness spaced equality of 1%. Use random excitation force to simulate variabilities.
2. Proposed and extract a list of possible features from these vibration signals to label the structural state. Compare the performance of both to decide what is the best combination to compute a damage index
3. Determine the Mahalanobis square distance using half sample of the healthy data as learning data and healthy data and all damaged data to validate. Perform it randomly, assuming a variable number of samples for learning (training) and validate (testing). Discuss the use of other possible damage index.
4. Compute the threshold value to a binary classification (healthy or damaged state) using at least two approaches.
5. Compute the confusing matrix with the probability of detection and probability of false alarm. Show the ROC curve.
6. Find the less loss of stiffness that your algorithm can detect with a probability of detection of 95% and less than 5% of false alarm. Show a plot of the loss of stiffness with the probability of detection.
7. Show all the results with plots and table with a report.
8. Discuss critically your results, disadvantages, and how you can enhance the method.
