pumpMaster 1.0.0

pumpMaster is an application which predicts the imminent failure of pumps and comparable turbomachines. Preemptive warnings or alerts prevent catastrophic failure by triggering timely operator/controller intervention. Such an intervention is crucial for safety and reliability of operators and high value critical systems. **pumpMaster** is able to make these predictions because it continuously listens to sensor data streams and identifies signal patterns which predict failure. At its heart is a simple linear regression model trained on time series sensor data. Section 1 details the data set and the motivations behind it.

1. Data Set

pumpMaster is trained with and demonstrated on the Pump Sensor Dataset from Keggle. The DataSet consists of indices, time-stamped signals from 52 sensors and machine status as NORMAL, BROKEN or RECOVERING. There are three motivations to use this data-set.

1. It a very a realistic data-set as this is how industrial logs are also maintained.
2. The data is raw, signal is noisy and it contains 7 different failures.
3. Though the sensors are not annotated, they provide sufficient indication for failure (taking one example in Figure 1) thus, are sufficient to build a predictor.

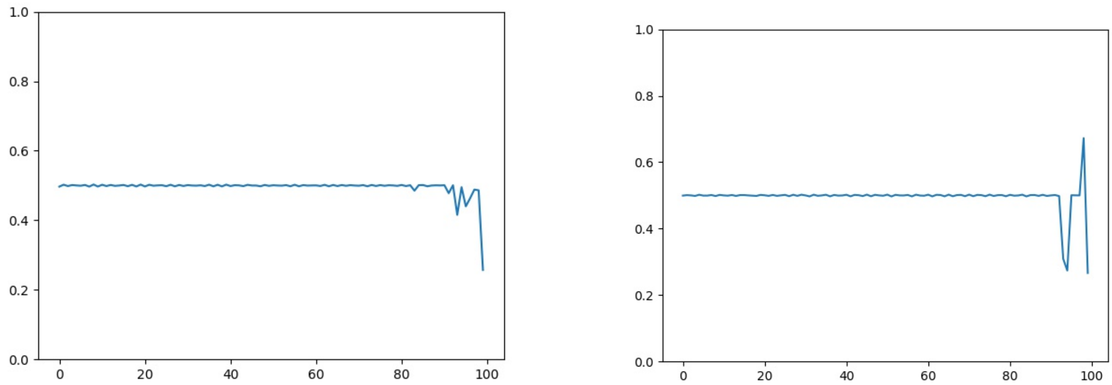


Figure 1: Sensor data preempting failure about 10 minutes before actual failure

2. Formulation

At first glance the machine state labels make it seem like a classification problem, however, pumps are not typically designed to work with a lot of variations in parameters speaking from my experiences in Mechanical, Aerospace, Maritime industries. A good measure for how well it is performing is:

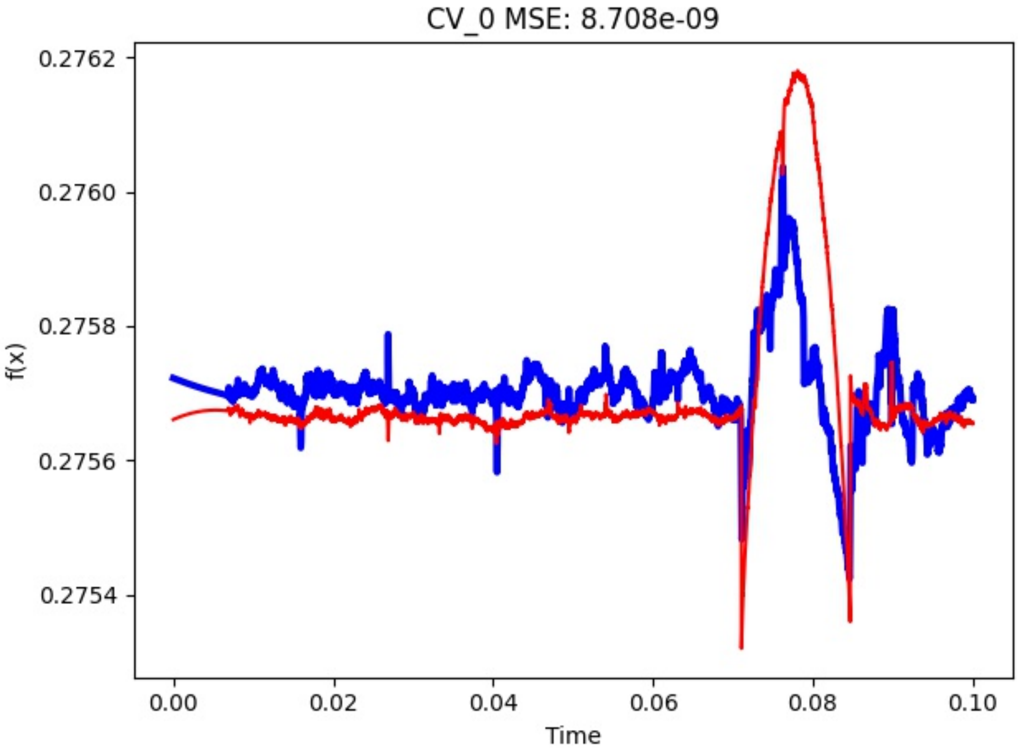
$$y_t = \frac{1}{52}\sum_{i=1}^{52}\frac{\partial s_i(t)}{\partial t} + y_c$$; Where $y_c \in \{0,1\}$, 0 - Normal/Recovering, Broken, s_i is i-th signal

This function is now continuous and with Exponentially Weighted Moving Averages, we would be able to make predictions of the form:

$$y_t' = f\left(\text{ewm}\left(\frac{\partial s_0}{\partial t}\right), \ldots, \text{ewm}\left(\frac{\partial s_{52}}{\partial t}\right)\right)$$

3. Regression

An ordinary least square regression is now sufficient as seen from cross-validation results.



Cross Validation studies