### Automatic Threshold Detection for Engine Speed

#### Introduction

The objective of this project is to automatically identify a threshold that distinguishes between idle and work states based on the engine speed signal of different machines. The data consists of engine speed tracked over 20,000 seconds at 1 Hz for 5 machines.

#### Data Preprocessing

##### Assumptions

* Engine speed directly correlates with machine activity.
* Two primary states: idle and work.
* Outliers are at 0 rpm and above 2500 rpm.

##### Approaches

* Removed rows where engine speed is either 0 rpm or above 2500 rpm.
* No normalization was required.

#### Methodology

##### Model Selection

* Gaussian Mixture Models (GMM) were used to identify the two distributions corresponding to idle and work states.

##### Configuration

* Number of components for GMM: 2
* Random state: 42

#### Results

##### Identified Thresholds

* Machine 0: 699.91 rpm
* Machine 1: 784.28 rpm
* Machine 3: 639.41 rpm
* Machine 4: 1135.67 rpm

##### Time Spent in States

* Machine 0: Idle 19.66%, Work 80.34%
* Machine 1: Idle 3.79%, Work 96.21%
* Machine 3: Idle 21.84%, Work 78.16%
* Machine 4: Idle 37.42%, Work 62.58%

#### Evaluation Metrics

* Likelihood Scores:
  + Machine 0: -6.08
  + Machine 1: -6.06
  + Machine 3: -6.12
  + Machine 4: -6.46

These scores are similar across machines, suggesting that the model fits each machine's data with roughly the same level of "goodness-of-fit".

#### Conclusion

The Gaussian Mixture Model effectively identified thresholds for different machines. These thresholds were validated using the percentage of time spent in each state, providing a practical evaluation of the model's effectiveness