# Predictive Maintenance for Industrial Equipment

## Using NASA's Turbofan Engine Degradation Simulation Data

# Problem Statement

| Overview | Specific Objective | Impact |
|---|---|---|
| Develop an AI model to predict equipment failures in a manufacturing plant to minimize downtime and maintenance costs. | Predict the Remaining Useful Life (RUL) of engines based on operational data and sensor measurements. | Early detection of potential failures can help schedule maintenance, reducing unexpected downtime and associated costs. |

# Dataset Overview

Link: ://data.nasa.gov/Aerospace/CMAPSS-Jet-Engine-Simulated-Data/ff5v-kuh6/about_data

01. Source: NASA's Turbofan Engine Degradation Simulation Data Set

02. Description: The dataset consists of multivariate time series data from multiple engines, each representing a different engine under varying conditions and fault modes.

03. Data Splits: Training and test sets with multiple engines' data.

# Dataset Details

| Dataset | Description |
|---|---|
| FD001 | Single operating condition, single fault mode |
| FD002 | Multiple operating conditions, single fault mode |
| FD003 | Single operating condition, two fault modes |
| FD004 | Multiple operating conditions, two fault modes |

| Features | Description |
|---|---|
| Columns | Unit number, time in cycles, operational settings (3), sensor measurements (26) |
| Total Columns | 26 |
| Goal | Predict RUL (Remaining Useful Life) based on the features provided |

# Data Characteristics

## 01

Initial Conditions: Engines start with different degrees of wear and manufacturing variations.

## 02

Fault Development: The fault grows in magnitude until failure in the training set; the test set ends before failure.

## 03

Sensor Data: Includes noise, requiring robust preprocessing and feature engineering.

# Challenges and Considerations

## 01

Data Noise: Sensor readings may include noise that needs to be filtered out.

## 02

Data Variability: Variability in operational settings and initial conditions.

## 03

Feature Selection: Identifying which features are most predictive of RUL.

# Methodology

- For a comprehensive understanding of the methodologies and techniques used in this project, including data processing, feature engineering, model selection, and hyperparameter tuning, please refer to the Jupyter Notebook file attached (project1.ipynb).
- The notebook contains detailed explanations, visualizations, and code snippets that illustrate the entire workflow from data collection to model evaluation.
- **Key sections in the notebook:**
- Data Exploration and Visualization: Insight into the dataset and initial observations.
- Feature Engineering: Methods used to extract and transform features.
- Modeling and Evaluation: Details on the models tested, including Ridge and Lasso Regression, Decision Trees, and the hyperparameter optimization process.
- Results and Discussion: Analysis of the model performance and findings.

# Thank you very much!

*Kindly run the python code provided for results and their significance.