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foundation

# Jet Engine Failure Prediction using Machine Learning



# Learning Objectives

- ❑ Understand the structure and purpose of the NASA C-MAPSS FD001 dataset
- ❑ Learn how to preprocess multivariate time-series sensor data for machine learning
- ❑ Build a modular pipeline to extract last-cycle engine data
- ❑ Train and evaluate a Random Forest model for Remaining Useful Life (RUL) prediction
- ❑ Visualize model performance and interpret feature importance
- ❑ Create a simple Streamlit frontend for interactive RUL prediction



# Tools and Technology used

- ❑ **Python** – Core programming language for data analysis and modeling
- ❑ **Pandas & NumPy** – Data preprocessing and manipulation
- ❑ **Scikit-learn** – Machine learning model training and evaluation
- ❑ **Matplotlib & Seaborn** – Visualization of results and feature importance
- ❑ **Streamlit** – Frontend interface for interactive RUL prediction
- ❑ **VS Code** – Development environment for coding and debugging
- ❑ **Jupyter Notebook** – Exploratory analysis and modular pipeline development

# Methodology

## 1.Dataset Discovery

Searched and selected the FD001 subset from NASA's C-MAPSS dataset for engine degradation modeling.

## 2.Data Preprocessing

Extracted last-cycle data per engine, selected relevant sensor features, and ensured reproducibility.

## 2.Model Training

Trained a Random Forest Regressor to predict Remaining Useful Life (RUL) using selected features.

## 3.Model Evaluation

Assessed performance using RMSE and  $R^2$  score; visualized true vs predicted RUL.

## 4.Interpretability

Generated a feature importance chart to explain sensor influence on predictions.

## 5.Frontend Development

Built a simple Streamlit app for interactive engine-wise RUL prediction.

## Problem Statement:

Jet engines experience wear and degradation over time, making unexpected failures a serious risk to safety and operations. Traditional maintenance schedules may not detect early signs of failure, leading to costly downtime or catastrophic events. There is a need for a data-driven approach to predict engine health and Remaining Useful Life (RUL) using real-time sensor data.

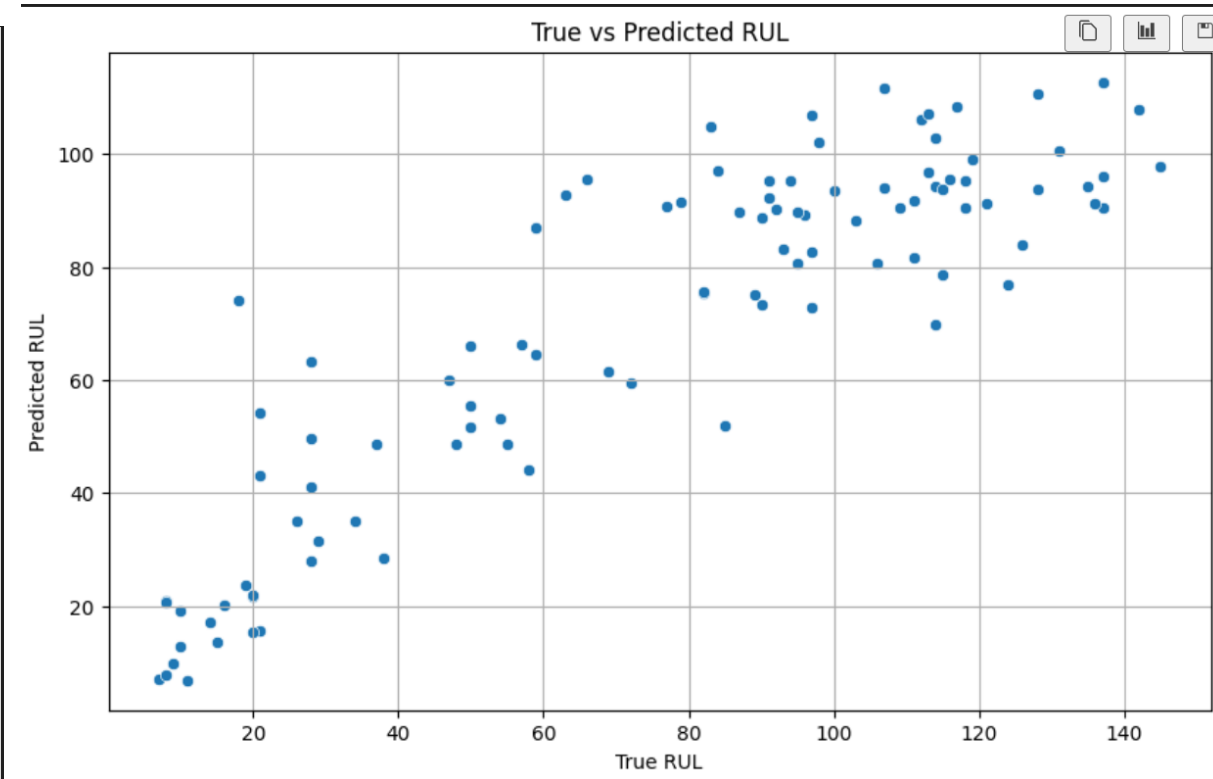
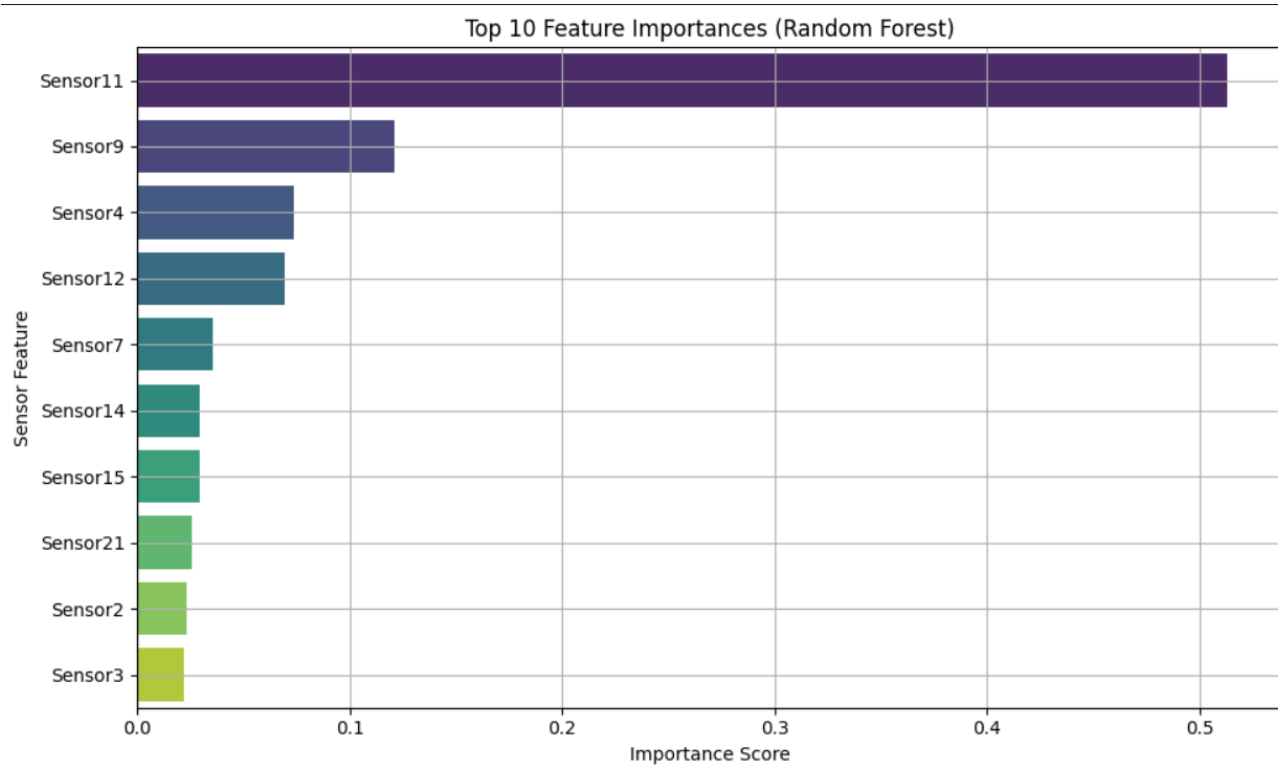
## Solution:

Developed a modular machine learning pipeline that predicts the Remaining Useful Life (RUL) of jet engines using sensor data from the NASA C-MAPSS FD001 dataset.

The solution includes:

- ❖ A Random Forest model trained on last-cycle sensor readings
- ❖ Visualizations for true vs predicted RUL and feature importance
- ❖ A Streamlit-based frontend for interactive engine-wise prediction
- ❖ Clean documentation and reproducible code for submission and future extension

## Screenshot of Output:



### Model Evaluation

RMSE

20.76

R<sup>2</sup> Score

0.75

## Conclusion:

- ❑ Successfully built a modular and interpretable machine learning pipeline to predict jet engine RUL
- ❑ Achieved strong performance with Random Forest ( $R^2 = 0.75$ , RMSE = 20.76)
- ❑ Visualized key sensor contributions using feature importance charts
- ❑ Developed a user-friendly Streamlit frontend for interactive predictions
- ❑ Demonstrated the potential of data-driven predictive maintenance in aerospace applications