Predictive Maintenance Project

Detailed Project Report

Agenda

- Introduction
- Data Overview
- Model Selection
- Model Training & Evaluation
- FAQs
- Future Work

Introduction

- Overview of Predictive Maintenance:
  - Predictive maintenance uses data analysis to predict when equipment will need maintenance
- Importance in industrial applications:
  - Prevents unexpected downtime, reduces maintenance costs, and improves reliability
- Project motivation and goals:
  - To leverage machine learning to predict the Remaining Useful Life (RUL) of engines.

Objectives

- Primary Objective:
  - ✓ Predict Remaining Useful Life (RUL) of engines
- Secondary Objectives:
  - ✓ Improve operational efficiency
  - ✓ Ensure modularity
  - ✓ Scope of upgradation

Data Overview

This is a very well known public data set for asset degradation modeling from NASA. It includes Run-to-Failure simulated data from turbo fan jet engines.

There are three operational settings that have a substantial effect on engine performance. These settings are also included in the data.

There are 21 sensors, the data is contaminated with sensor noise.

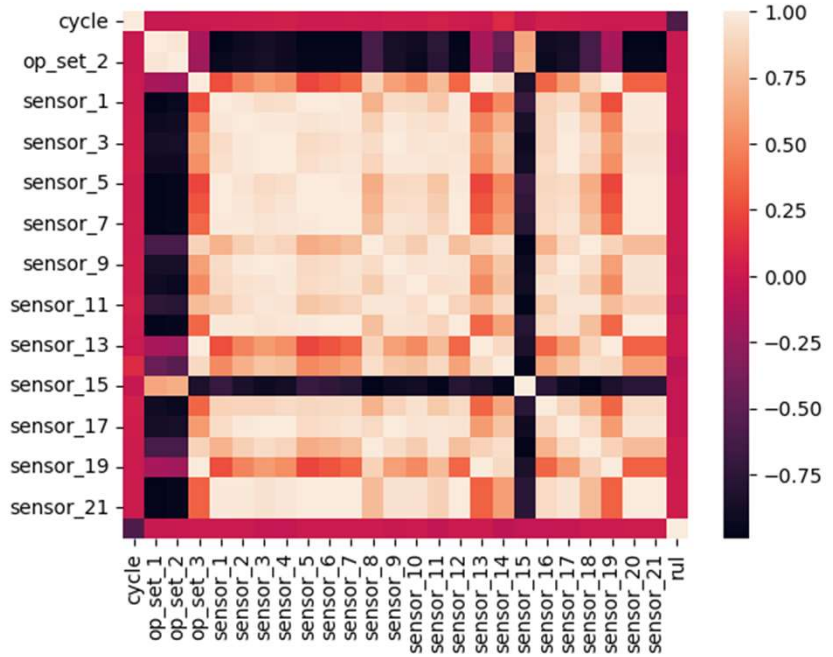
Data sets consists of multiple multivariate time series. Each time series is from a different engine.

Data consists of 26 features:

- Unit Number
- Time in Cycles
- Operational Settings 1 to 3
- Sensor Measurements 1 to 21

Data Transformation and Validation

- Data Preprocessing
  - Handling missing values: No missing values in our dataset
  - Standardization: Normalize data for consistent scale
- Feature Engineering
  - Creating relevant features from raw data
- Validation
  - Splitting data into training and cross-validation sets



Model Selection

Considered Models:

- Linear Regression.
- Decision Trees
- Random Forests
- Neural Networks

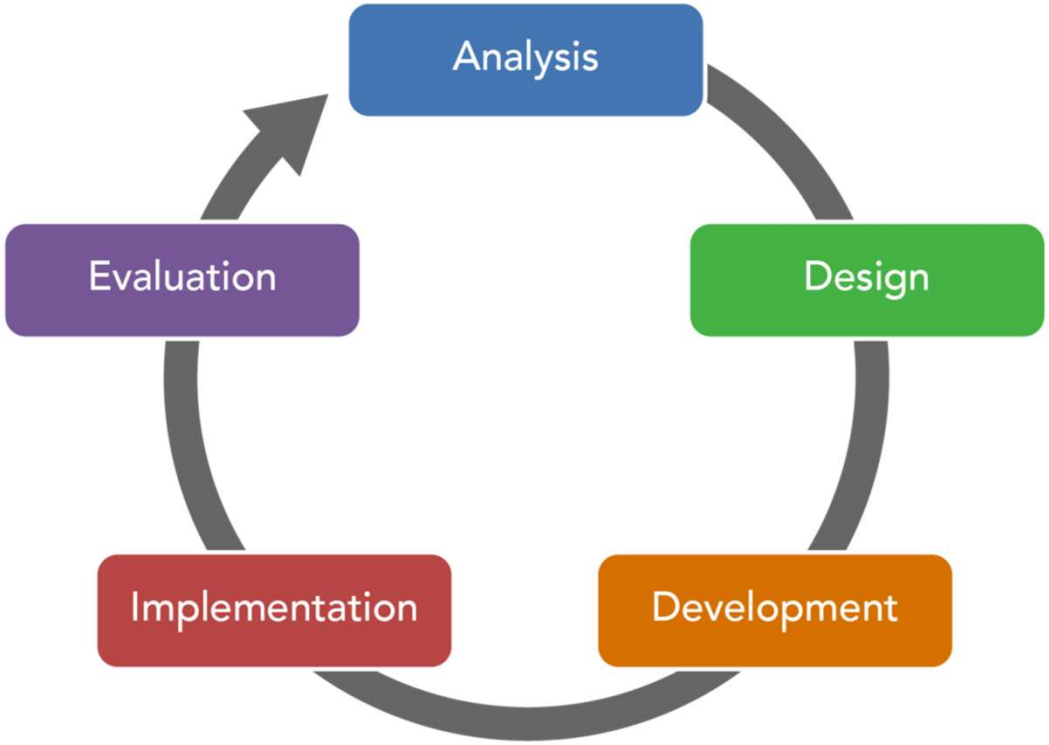
Criteria for Selection:

- Accuracy
- Interpretability
- Computational efficiency

Model Training

Training Process

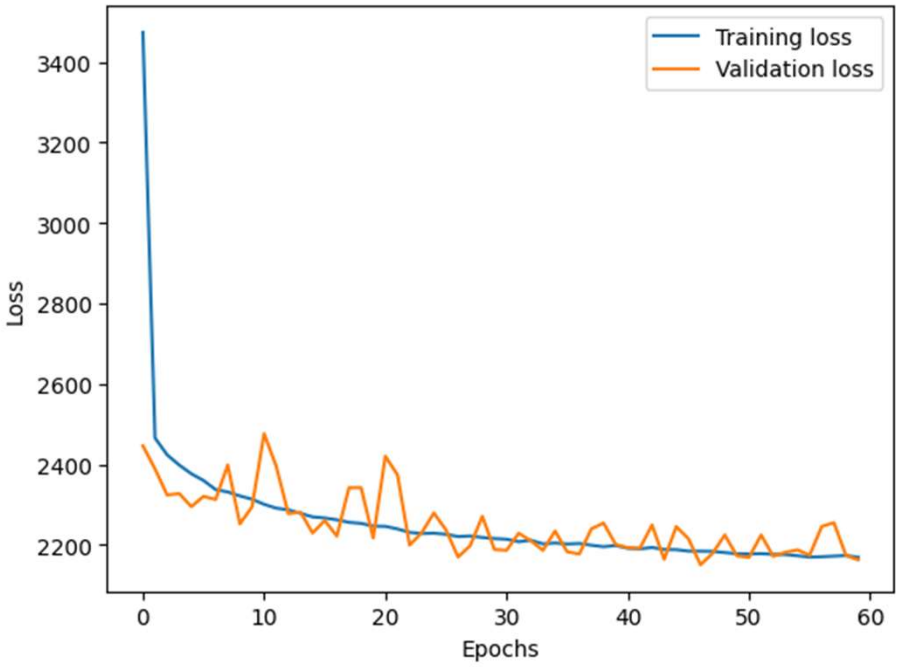
- Data preparation: Cleaning and transforming data
- Hyperparameter tuning: Optimizing model parameters
- Cross-validation: Ensuring model generalization



Model Evaluation

Evaluation Metrics

- Mean Squared Error (MSE)
- Root Mean Squared Error (RMSE)
- R-Squared



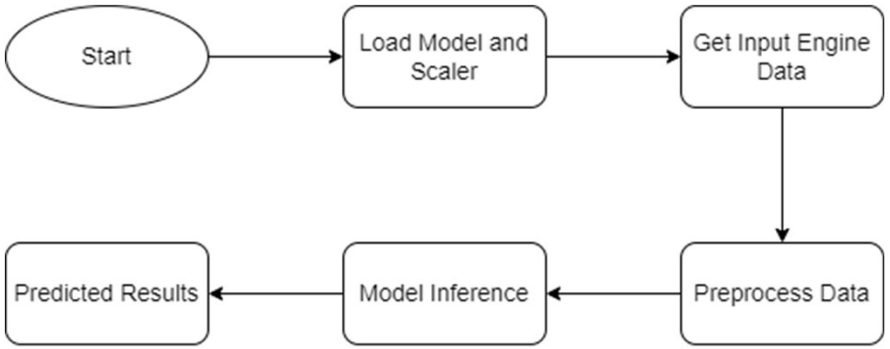
Prediction

•Prediction Workflow

1. Input new engine data
2. Data preprocessing
3. Model inference
4. Output RUL predictions

Real-time Prediction

- Integration with monitoring systems



Benefits

Operational Benefits:

- Reduced downtime
- Optimized maintenance
- Cost savings

Business Impact

- Improved reliability
- Enhanced decision-making
- Competitive advantage

FAQs

1. What is the primary data source?
    - Engine sensor data collected over time.
2. How is the model validated?
    - Using cross-validation on the training dataset.
3. Can the system handle real-time data?
    - Yes, it is designed for real-time prediction integration.

Future Work & Conclusion

Potential Enhancements

- Incorporating more advanced models (e.g., LSTM)
- Expanding to other types of machinery
- Continuous improvement based on feedback

Summary

- Successful implementation of a predictive maintenance model
- Achieved project objectives
- Demonstrated benefits and potential business impact

Thank you

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