📄 Weekly Progress Report

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Domain: Predictive Maintenance using ML
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Week Ending: 01

I. Overview:

This week marked the initiation of the internship with a focus on Predictive Maintenance. I selected and explored three key projects:

1. **Turbofan Engine RUL Prediction**
2. **Bearing Lifetime Prediction**
3. **Gearbox Fault Diagnosis Using Vibration Sensors**

Initial efforts included data exploration, understanding the failure modes, organizing the datasets, and preparing the environment for analysis and modeling.

II. Achievements:

1. Project 6 – Turbofan Engine RUL Prediction

- Explored FD001 dataset with 100 training and 100 testing engine trajectories.
- Visualized sensor trends (26 sensors) over operational cycles.
- Created preliminary target labels for RUL estimation using a linear degradation approach.
- Started exploratory data analysis to identify key features influencing degradation.

2. Project 7 – Bearing Lifetime Prediction

- Downloaded and parsed Set 1 of the IMS bearing dataset (2,156 ASCII files).
- Built Python scripts to extract vibration signal features: RMS, skewness, kurtosis, and crest factor.
- Automated feature extraction pipeline for continuous monitoring and health tracking.
- Plotted bearing signal patterns to identify the early signs of failure in bearings 3 & 4.

3. Project 8 – Gearbox Fault Diagnosis Using Vibration Sensors

- Downloaded dataset recorded under two conditions: Healthy vs. Broken Tooth.
- Understood sensor placement and impact of load variations (0% to 90%).
- Preprocessed raw vibration data and compared healthy vs faulty gearbox responses.
- Built a basic fault classification pipeline using FFT and statistical descriptors.

4. Python Learning Enhancement

- Practiced libraries like NumPy, Pandas, Matplotlib, Scikit-learn, and Seaborn.
- Started tutorials on time series modeling and signal processing (PyWavelets, SciPy).
- Applied knowledge in feature extraction and model preparation for real-world datasets.

III. Challenges:

1. File Handling & Memory Usage (Bearing & Gearbox Projects)

- Handling large vibration data files slowed down processing.
- Solved partially using chunk-wise reading and memory-efficient techniques.

2. Label Mapping Issues (Turbofan Project)

- Faced difficulty aligning test set cycles with the RUL ground truth.
- Currently working on a dynamic mapping strategy for evaluation.

3. Feature Engineering for Signal Data

- Signal transformation and feature extraction for gearbox and bearing datasets was complex.
- Started exploring Wavelet Transform and Spectral Entropy for enhancement.

IV. Learning Resources:

- NASA CMAPSS dataset paper: *"Prognostics Data Repository – Turbofan Engine Degradation Simulation"*
- Medium/Kaggle articles on vibration-based predictive maintenance and RUL prediction.
- Signal processing tutorials on YouTube (FFT, STFT, Wavelet).
- Participated in forums like StackOverflow and Kaggle for code optimization and troubleshooting.

V. Next Week's Goals:

- Train and evaluate LSTM/GRU-based models for RUL prediction (Project 6).
- Complete feature engineering and start model development for bearing life prediction (Project 7).
- Build a CNN or SVM model for gearbox fault classification (Project 8).
- Create comparative analysis dashboards for all three projects.
- Document data preprocessing and modeling pipelines for reproducibility.

VI. Additional Comments:

This week gave me a strong foundation in predictive maintenance concepts. Working on three real-world industrial datasets helped me improve my data preprocessing, visualization, and model planning skills. Looking forward to building baseline models and improving performance in the upcoming week.