🔧 Hybrid Predictive Maintenance using NASA CMAPSS (FD001)

Group Name: G_CSE225_CSE204_CSE243_CSE063_UMCS063

Project Title: Hybrid Predictive Maintenance using NASA CMAPSS Dataset

A Streamlit App for Engine Health Monitoring and RUL Prediction

📌 Objective:
This project predicts engine degradation stages and Remaining Useful Life (RUL) using NASA's CMAPSS dataset. It combines unsupervised clustering, classification, regression, and risk alerting in an interactive web interface.

📊 Key Features:

- **KMeans Clustering (5 Stages):** Automatically labels engine health as Normal → Slightly Degraded → Moderately Degraded → Critical → Failure.
- **Interactive Dashboard:** Select any engine to visualize its sensor readings over time.
- **Stage Classification:** Uses RandomForestClassifier to classify current degradation stage.
- **RUL Prediction:** Predicts how many cycles are left before failure using RandomForestRegressor.
- **Risk Alerts:** Triggers alerts if RUL < 20 cycles & stage ≥ 3 with high probability.
- **Confusion Matrix & Metrics:** Visual performance reports using heatmaps and scoring.

🧠 Models Used:

- KMeans (for clustering stages)
- RandomForestClassifier (for stage classification)
- RandomForestRegressor (for RUL prediction)

📂 Dataset:

- **Source:** NASA CMAPSS FD001 ([Kaggle Link](#))
- Contains sensor readings across engine cycles with no predefined labels.

⚙ **Tech Stack:**

Python, Streamlit, Pandas, Scikit-learn, Matplotlib, Seaborn

▶ **How to Run:**

1. Install libraries (pip install -r requirements.txt)
2. Place train_FD001.txt in the root folder
3. Run with streamlit run app.py

Team Members and Contributions:

1. Saiteja (SE23UCSE225) – 30%
   a. Developed the Streamlit application interface
   b. Implemented classification and regression models
   c. Designed risk alert logic and visualizations
2. Sravani (SE23UCSE204) – 25%
   a. Worked on regression-based RUL prediction
   b. Helped with sensor trend analysis and model evaluation
3. Shiva Karan Reddy (SE23UCSE063) – 15%
   a. Assisted in data preprocessing and dataset merging
   b. Supported clustering and labeling stage development
4. Varshitha (SE23UMCS063) – 15%
   a. Responsible for report drafting and formatting
   b. Helped refine charts and metrics in the report
5. Tilak (SE23UCSE243) – 15%
   a. Contributed to writing documentation and error-checking code
   b. Helped compile final folder structure and submission

All team members contributed to reviewing and finalizing the report and code.