Description for the Group Portfolio (40%)

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1 Marine vessel propulsion systems

Gas turbines in marine vessels are used as the main propulsion system or as part of a combined propulsion system. These turbines offer several advantages, including high power output, compact size, and relatively low weight compared to traditional marine diesel engines. They are particularly valued in military and high-speed commercial vessels for their ability to provide rapid acceleration and high speeds.

This dataset contains records of marine vessel propulsion plants designed for condition-based maintenance. It includes 16-dimensional vectors of gas turbine (GT) measures in steady-state operation, along with decay state coefficients for both the GT compressor and turbine. Key parameters include lever position, ship speed, shaft torque, revolution rates for the GT and gas generator (GG), starboard and port propeller torques, turbine exit temperature and pressure measurements, fuel flow rate, and more. These parameters together offer a comprehensive overview of a vessel's mechanical health, supporting safer and more efficient operations, even under challenging environmental conditions or high-traffic scenarios.

Data Description:

- Lever position (measure in RPM-Low to High): Position of the ship's lever.
- Ship speed (v): Speed of the ship, likely in knots.
- Gas Turbine (GT) shaft torque (GTT): Torque on the gas turbine shaft in kN m.
- GT rate of revolutions (GTn): Revolutions per minute (rpm) of the gas turbine.
- Gas Generator rate of revolutions (GGn): Revolutions per minute (rpm) of the gas generator.
- Starboard Propeller Torque (Ts): Torque on the starboard propeller in kN.
- Port Propeller Torque (Tp): Torque on the port propeller in kN.
- High Pressure (HP) Turbine exit temperature (T48): Temperature at the exit of the high-pressure turbine in Celsius.
- GT Compressor inlet air temperature (T1): Temperature of inlet air to the gas turbine compressor in Celsius.
- GT Compressor outlet air temperature (T2): Temperature of outlet air from the gas turbine compressor in Celsius.
- HP Turbine exit pressure (P48): Pressure at the exit of the high-pressure turbine in bar.
- GT Compressor inlet air pressure (P1): Pressure of inlet air to the gas turbine compressor in bar.
- GT Compressor outlet air pressure (P2): Pressure of outlet air from the gas turbine compressor in the bar.
- GT exhaust gas pressure (Pexh): Pressure of exhaust gas from the gas turbine in the bar.

- Turbine Injection Control (TIC): Control parameter for turbine injection in percentage.
- Fuel flow (mf): Rate of fuel flow into the gas turbine in kg/s.
- GT Compressor decay state coefficient : Coefficient related to the decay state of the compressor
- GT Turbine decay state coefficient: Coefficient related to the decay state of the gas turbine. (Note- usually a drop of 5-10% in efficiency might be considered critical for gas turbines

2 Battery Remaining Useful Life

The Hawaii Natural Energy Institute studied 14 NMC-LCO 18650 batteries, each with a nominal capacity of 2.8 Ah, cycled over 1,000 times at 25°C. The charging was done at a CC-CV rate of C/2, and discharging at a rate of 1.5C. From this dataset, we have extracted features that capture the voltage and current behavior during each cycle. These features can be used to predict the remaining useful life (RUL) of the batteries. The dataset provides a summary of the performance of all 14 batteries.

Data description:

- Cycle Index: number of cycle
- F1: Discharge Time (s)
- F2: Time at 4.15V (s)
- F3: Time Constant Current (s)
- F4: Decrement 3.6-3.4V (s)
- F5: Max. Voltage Discharge (V)
- F6: Min. Voltage Charge (V)
- F7: Charging Time (s)
- RUL: target

3 Wind turbine predictive maintenance

Renewable energy sources play an increasingly important role in the global energy mix, as the effort to reduce the environmental impact of energy production increases. Out of all the renewable energy alternatives, wind energy is one of the most developed technologies worldwide. The US Department of Energy has put together a guide to achieving operational efficiency using predictive maintenance practices. Predictive maintenance uses sensor information and analysis methods to measure and predict degradation and future component capability. The idea behind predictive maintenance is that failure patterns are predictable and if component failure can be predicted accurately and the component is replaced before it fails, the costs of operation and maintenance will be much lower. The sensors fitted across different machines involved in the process of energy generation collect data related to various environmental factors (temperature, humidity, wind speed, etc.) and additional features related to various parts of the wind turbine (gearbox, tower, blades, break, etc.).

ReneWind is a company focused on improving the machinery and processes involved in wind energy production through machine learning. They have collected sensor data on generator failures in wind turbines, but due to confidentiality, the data has been ciphered. The type of data collected may vary between companies. The dataset contains 40 predictor variables and a target variable, with 20,000 observations in the training set and 5,000 in the test set. In the target variable, "1" indicates a failure, while "0" indicates no failure. The data provided is a transformed version of the original sensor data.

- Train.csv: To be used for training and tuning the models.

- Test.csv: To be used solely for testing the performance of the final model.

Both datasets contain 40 predictor variables and 1 target variable.

Tasks

- Presentation 1: Define the problem clearly, outlining the objectives and goals of the analysis or model. Prepare the dataset by handling missing values, removing duplicates, and ensuring data consistency. Create relevant plots to visualize the data and identify patterns or outliers.
- Presentation 2: Analyze the data using at least three different machine learning algorithms, such as SVM, Random Forest, XGBoost, Logistic Regression, etc. Use separate datasets for training and testing to evaluate model performance. Visualize the results of each model using appropriate plots. Compare and discuss the performance of the models, highlighting strengths, weaknesses, and key insights.
- Presentation 3: Integrate the digital twin model with predictive maintenance for the respective systems, using a dashboard interface for monitoring and visualization.
- Presentation 4: Develop an AI agent to retrieve information from the dataset and simulation.

Portfolio - Report

- Introduction (20%)
- Methodology (20%)
- Digital Twin Development (20%)
- AI-Agent Implementation (40%)

Maximum 20 pages. **Submission in Inspera between 11 - 15 May 2026.**