Case Study: Predictive Maintenance for Aircraft Engines

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Background

Aircraft engine maintenance is a critical aspect of aviation operations, playing a vital role in ensuring the safety, reliability, and efficiency of air travel. The maintenance of aircraft engines is a complex and highly regulated process that involves various preventive and corrective measures to keep engines in optimal working condition.

Case Study

- The goal of this project is to conduct a comprehensive Exploratory Data Analysis (EDA) and data analysis tasks on an aircraft engine maintenance dataset representing different aircraft engine health and operational parameters.
- The dataset simulates real-world scenarios in which engines operate under varying conditions, and our objective is to gain insights into the data through EDA, statistical analysis and visualizations.
- This is a critical task for the aviation industry, as it not only inform managements on how to enhance safety measures but also helps highlight maintenance costs and increase operational efficiency.

Dataset

➔ The aircraft dataset contains historical data from various aircraft engines.
➔ Each row in the dataset represents a specific engine at a given point in time.

Data Dictionary:

- Engine_ID (Unique identifier for each aircraft engine)
  - Type: Integer
- Timestamp (Date and time when the data was recorded)
  - Type: Datetime
- Temperature (Temperature of the aircraft engine in degrees Celsius)
  - Type: Float
- Pressure (Pressure of the aircraft engine in units relevant to the dataset)
  - Type: Float
- Rotational_Speed (Rotational speed of the aircraft engine in revolutions per minute (RPM))
  - Type: Float
- Engine_Health (A measure of the overall health of the aircraft engine.)
  - Type: Float

Dataset

- Engine_Failure (Binary indicator of engine failure (0 for ‘no engine failure’, 1 for ‘engine failure’)
  - Type: Integer (Binary)
- Fuel_Consumption (Amount of fuel consumed by the engine..)
  - Type: Float
- Oil_Temperature (Temperature of the engine oil.)
  - Type: Float
- Altitude (Altitude at which the engine operates.)
  - Type: Float
- Humidity (Humidity level in the environment where the engine operates.)
  - Type: Float
- Maintenance_Needed (Indicates whether maintenance is needed for the engine (1 for needed, 0 for not needed).)
  - Type: Integer (Binary)

Task

- Data Cleaning:
  - Handle missing values, outliers, and any anomalies in the dataset.
- Data Exploration:
  - Perform basic statistical analysis to understand the distribution of each feature.
  - Identify patterns and trends in the data.
- Univariate Analysis:
  - Analyze individual features to gain insights.
  - Examine the distribution of key variables.
- Bivariate Analysis:
  - Explore relationships between pairs of variables.
  - Identify correlations and dependencies.
- Multivariate Analysis:
  - Investigate interactions between three or more variables.
  - Discover complex patterns and dependencies.

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Task

- Data Visualization:
  - Create visualizations to effectively communicate insights.
  - Utilize plots, charts, and graphs to represent the data.
- Feature Engineering:
  - Derive new features that might enhance predictive performance.
  - Consider time-based features, rolling averages, or other relevant transformations.
- Data Summary:
  - Summarize key findings from the exploratory analysis.
  - Highlight insights that could inform the predictive maintenance model.
- **Predictive Analysis:**
  - Leverage different machine learning classification algorithms to predict if an engine will require maintenance or not.