Week 9 – Dashboard Development and User Training

Introduction:

In an intelligent manufacturing system, this script focuses on producing visual dashboards and analytical insights for tracking sensor data trends, feature significance, task scheduling, and machine faults. It incorporates verified task schedules and processed sensor data to assist with staff training and operational decision-making.

Objective:

To produce thorough analysis and visuals that:

- Monitor machine-to-machine work scheduling performance and failure patterns.
- Examine the behavior of sensor data before failures.
- Reduce the dimensionality of sensor data so that PCA can be used to train the model.
- Determine the significance of each attribute for predictive maintenance models.
- Provide training materials that help employees comprehend production procedures and how to prevent failures.

Methodology:

- **Data Loading:**
  - Translated timestamps for time-series analysis, processed sensor data, and imported verified work schedules.
- **Aggregation:**
  - Determined average delays, failure probability, task counts, and daily failure counts per machine.
- **Visualization:**
  - Plots with lines and bars showing total and daily machine failures.
  - Heatmaps showing the average daily delay per machine and the work scheduling burden.
  - The work priority distribution pie chart with the failure probability against delay scatter plot.
- **Dimensionality Reduction:**

    - To depict sensor patterns colored by failure state, StandardScaler normalized a subset of sensor data and then performed two-component PCA.
- **Prior to failure Sensor Trends:**
    - Line charts for important sensor variables were produced, and the "time to failure" for sensor readings within six hours prior to failure occurrences was calculated.
- **Correlation and Feature Importance:**
    - To ascertain the relative significance of features in failure prediction, a Heatmap of sensor feature correlations and a Random Forest classifier are used.
- **Training Materials:**
    - Condensed notes that synthesize results and visual aids for training operational staff.

Results & Observations:

- In order to facilitate focused monitoring, failure trends identified specific machines with regularly higher failure counts.
- Heatmaps of job scheduling revealed variations in workload and delays, which helped determine the necessity for rescheduling.
- PCA demonstrated clear grouping patterns between failure and non-failure conditions while reducing the complexity of sensor data.
- For predictive alarms, sensor characteristics such as temperature, vibration, and rpm showed significant changes in the hours before to failure.
- Correlation matrices supported feature selection by highlighting interdependencies among sensor data.
- Important sensor metrics affecting failure predictions were found using Random Forest feature importance.
- These observations were summarized in training notes, which encouraged industrial workers to be vigilant and do preventative maintenance.

Summary:

By effectively integrating data from several sources, this script produces an analytical dashboard suite and training materials that improve SmartFactory's operational transparency.AI. A complete toolbox to increase machine reliability and scheduling efficiency is provided by the combination of time-series failure analysis, scheduling load

assessment, sensor behavior study, and feature importance evaluation. Data-driven decision making and ongoing learning are supported by visualizations and staff training resources.

Conclusion:

Through interpretable data and hands-on training, the Week 9 outputs empower employees and enable real-time factory monitoring. The technology facilitates proactive maintenance strategies by identifying crucial sensor patterns and equipment that are prone to malfunction, which enhances production processes and reduces downtime. In later project phases, this fundamental work lays the groundwork for additional advancements in operational responsiveness and predictive models.

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