Fault Detection and Predictive Maintenance of Industrial Gas Turbine Engines

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Introduction

- Gas turbines are vital in midstream operations for compression.

- Unanticipated failures lead to safety hazards and losses.

- Objective: Apply machine learning for early fault detection and predictive maintenance.

Literature Review

- SVM and Random Forests effective for rotating machinery.

- Feature engineering: pressure ratios, temperature/vibration analysis.

- Outlier detection: Isolation Forest, DBSCAN.

- Time-series segmentation: Rolling averages, LSTM (Malhotra et al.).

Dataset Overview and Sources

- Source: Kaggle Gas Turbine Engine Fault Detection Dataset

- 1,386 samples: sensor readings (temperature, pressure, RPM).

- Supervised: Includes labeled operational/faulty states.

- Dataset: https://www.kaggle.com/datasets/ziya07/gas-turbine-engine-fault-detection-dataset

Data Preprocessing Techniques

- Handle missing values (imputation).

- Normalize sensor data.

- Feature engineering: pressure ratios, rolling averages.

- Segment time-series data for temporal trends.
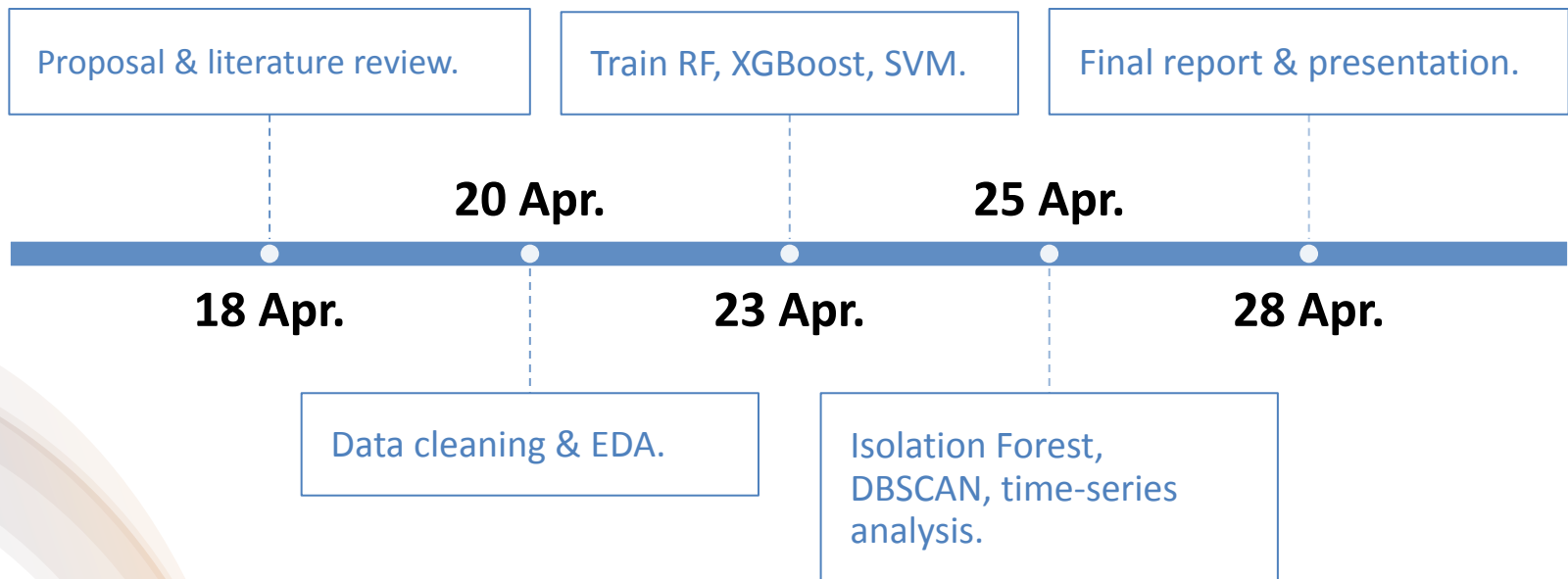
Modeling Strategies

- Supervised: Random Forest, XGBoost, SVM.

- Unsupervised: Isolation Forest, DBSCAN.

- Time-series: Rolling stats, segmenting operational cycles.

Evaluation Metrics and Validation

- Classification: Accuracy, Precision, Recall, F1-Score.
- Anomaly: ROC-AUC, Confusion Matrix, Anomaly Visualization.
- Validation: K-Fold Cross-Validation.
- Interpretability: SHAP values, Feature importances.

Project Timeline and Milestones

Proposal & literature review.

Train RF, XGBoost, SVM.

Final report & presentation.

20 Apr.

25 Apr.

18 Apr.

23 Apr.

28 Apr.

Data cleaning & EDA.

Isolation Forest, DBSCAN, time-series analysis.

Expected Impact and Applications

- Reduced downtime, optimized maintenance, cost savings.

- Enhanced safety in gas turbine operations.

- Applications: Pipelines, power plants, manufacturing.

Conclusion and Next Steps

- Machine learning improves turbine reliability and maintenance.

- Data understanding and data preprocessing

- Data Modeling and supervised learning to classify faulty equipment

- Pattern Evaluation