



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 hybrid predictive maintenance framework that addresses these limitations by combining temporal pattern recognition, semi-supervised learning, and explainable AI



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

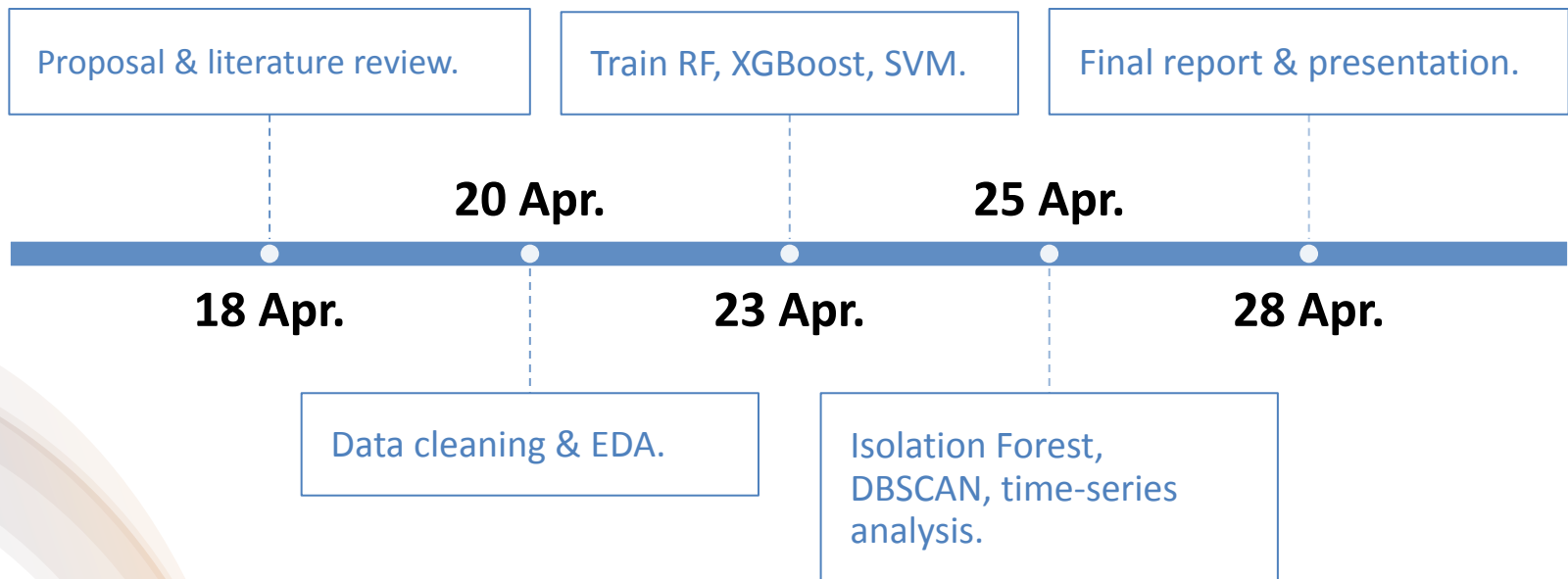
- Supervised: Random Forest, XGBoost, SVM.
- Unsupervised: Isolation Forest, DBSCAN.
- Time-series: Rolling stats, segmenting operational cycles.



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





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
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