### **Predictive Maintenance Report**

### **1. Executive Summary**

A predictive maintenance solution was developed for a manufacturing plant operating 100 machines. The goal was to reduce downtime by forecasting equipment failures within the next 30 days. A machine learning model using Random Forest was trained on historical sensor data, maintenance logs, and machine metadata. The model achieved strong performance (AUC-ROC: 0.79) and produced actionable insights for prioritizing maintenance activities.

### **2. Business Problem & Objectives**

Downtime due to unexpected equipment failures increases operational costs and reduces efficiency. The objective of this analysis was to:

* Predict failures within a 30-day window.
* Recommend maintenance schedules for high-risk machines.
* Provide a visual dashboard for daily monitoring.

### **3. Data Overview**

Three datasets were integrated:

* **Sensor Readings** (100,000 rows): Time-series data on temperature, vibration, pressure, and runtime hours.
* **Maintenance Logs** (5,000 rows): Records of failures, repair types, and downtime.
* **Machine Metadata** (100 rows): Includes machine type, age, and last overhaul date.

**Data Preparation Highlights:**

* Imputed missing values in vibration and repair type.
* Removed temperature outliers using IQR filtering.
* Aggregated sensor data to daily averages.
* Engineered features like rolling averages and days since last overhaul.

### 

### **4. Modeling Approach**

A Random Forest Classifier was trained to predict the binary target: failure in the next 30 days. Key steps:

* **Features Used:** Temperature, Vibration, Pressure, Runtime, Rolling Averages, Age, and Days Since Overhaul.
* **Target:** Binary label indicating failure occurrence in next 30 days.

**Model Results:**

* **AUC-ROC:** 0.79
* **Precision:** 0.74
* **Recall:** 0.71
* **Top Predictors:** Vibration Rolling Avg, Days Since Overhaul, Runtime Hours

### **5. Maintenance Recommendations**

From the model predictions, top 10 machines with highest failure probabilities were identified:

| **MachineID** | **Predicted Failure Probability** | **Recommended Maintenance Date** |
| --- | --- | --- |
| 47 | 0.91 | 2025-06-15 |
| 12 | 0.89 | 2025-06-15 |
| ... | ... | ... |

(Full table top10\_recommendations.csv)

### **6. Visualization & Dashboard**

A Tableau dashboard was created with:

* **Line Chart:** Daily failure probabilities by MachineID
* **Table:** Top 10 high-risk machines with maintenance recommendations
* **Filters:** MachineType, AgeYears

These visualizations allow daily monitoring and operational planning.

### 

### **7. Next Steps**

* Validate model results over real-time incoming data.
* Integrate with CMMS (maintenance system) to auto-generate work orders.
* Expand prediction window or include additional sensor inputs (e.g., acoustic, voltage).

**Conclusion:** The predictive maintenance model effectively identifies machines at risk of failure, enabling proactive interventions. This reduces unplanned downtime and improves operational reliability.



