# CAPSTONE PROJECT

# PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY


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# OUTLINE

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- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
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# PROBLEM STATEMENT

Develop a predictive maintenance model for a fleet of industrial machines to anticipate failures before they occur. This project aims to analyze sensor data from machinery to identify patterns that precede a failure. The goal is to create a classification model that can predict the type of failure (e.g., tool wear, heat dissipation, power failure) based on real-time operational data. This will enable proactive maintenance, reducing downtime and operational costs.

# PROPOSED SOLUTION

- The proposed system addresses the challenge of industrial machine failures by leveraging machine learning. The solution consists of the following components:
- Data Analysis:
  - Use a dataset containing sensor data (Temperature, Rotational Speed, Torque, etc.,)  to understand pattern.
- Data Preprocessing:
  - Clean and prepare the data for the model by handling categorical features and splitting the data into training and testing sets.
- Machine Learning Algorithm:
  - Implement a Random Forest Classifier to learn the relationship between sensor data and machine failures.
- Prediction:
  - Use the trained model to predict the type of failure for new, unseen data, providing an early warning of malicious activities.

# SYSTEM APPROACH

**The project was developed using a standard machine learning workflow on the IBM Cloud platform:**

- **Platform:** IBM Cloud Lite services / IBM Watsonx AI Studio
- **Programming:** Python 3.11
- **Libraries:** **Pandas** for data manipulation, **Scikit-learn** for model building, and **Matplotlib/Seaborn** for data visualization.

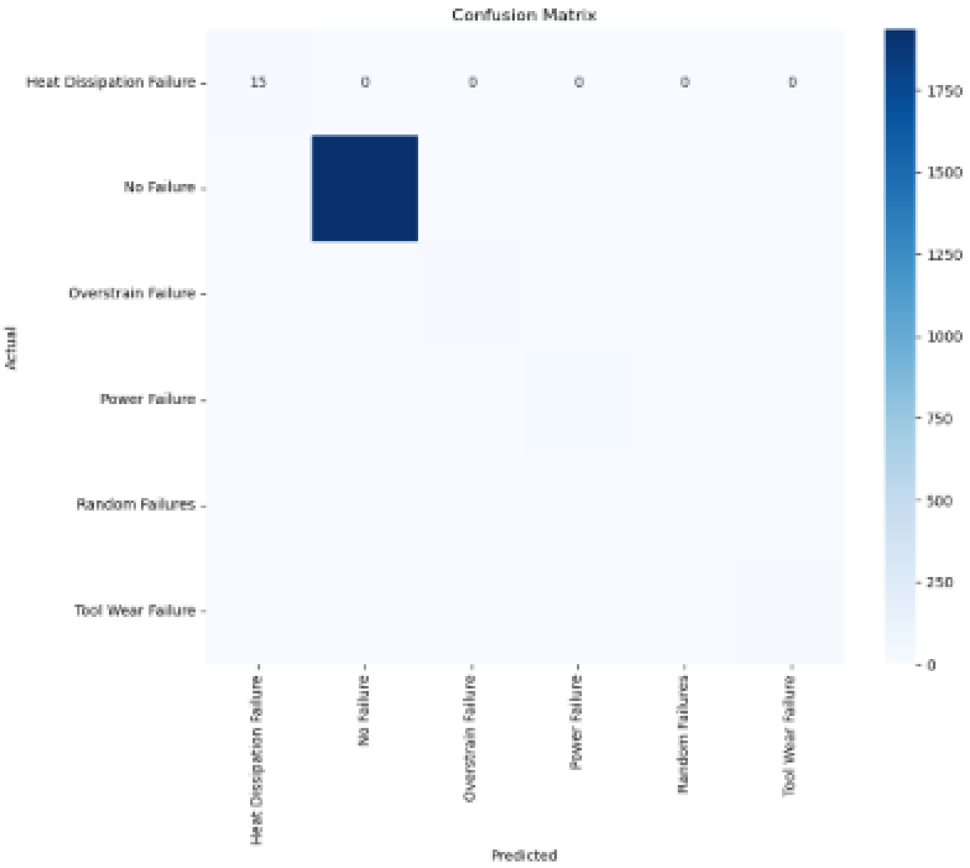
**The entire project was executed in a Jupyter Notebook, allowing for an iterative and transparent development process.**

# ALGORITHM & DEPLOYMENT

- Algorithm Selection:
  - We chose the **Random Forest Classifier**, a powerful ensemble learning model well-suited for multi-class classification problems like this. It constructs a multitude of decision trees to make a more accurate and robust prediction.
- Training Process:
  - The model was trained on **8,000** data points (80% of the dataset) to learn the patterns associated with different failure types.
- Prediction Process:
  - The trained model was then used to predict failures on **2,000** unseen data points (20% of the dataset).

# RESULT

The model achieved an outstanding **overall accuracy of 99%** on the test data. The results, as shown in the Confusion Matrix and Classification Report, highlight the model's effectiveness.




## Confusion Matrix

- The matrix shows that the model successfully predicted "No Failure" a vast majority of the time. The diagonal cells, which show correct predictions, are significantly high.

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Heat Dissipation Failure | 0.94 | 1.00 | 0.97 | 15 |
| No Failure | 1.00 | 1.00 | 1.00 | 1935 |
| Overstrain Failure | 0.79 | 0.85 | 0.81 | 13 |
| Power Failure | 0.95 | 0.95 | 0.95 | 20 |
| Random Failures | 0.00 | 0.00 | 0.00 | 6 |
| Tool Wear Failure | 1.00 | 0.82 | 0.90 | 11 |
| accuracy | | | 0.99 | 2000 |
| macro avg | 0.78 | 0.77 | 0.77 | 2000 |
| weighted avg | 0.99 | 0.99 | 0.99 | 2000 |

## Classification Report

- **Accuracy:** 0.99
- **Precision/Recall:** The model performs very well on most failure types, with Precision and Recall scores of 0.95 or higher for Heat Dissipation Failure and Power Failure.
- **Warning:** The report shows a warning for Random Failures due to a very low number of samples (6 instances), which can be addressed in the future.

# CONCLUSION

- The machine learning model for predictive maintenance is a success. It achieved a high level of accuracy and can effectively predict a range of common industrial machine failures. This solution can significantly reduce machine downtime and operational costs by enabling proactive maintenance, fulfilling the core objective of the problem statement.

# FUTURE SCOPE

- **Improved Data:** To enhance the model's performance on rare failure types, a larger and more balanced dataset would be beneficial.
- **Real-time Integration:** The model could be integrated with a live data stream from sensors to provide real-time predictions and maintenance alerts.
- **Predictive Dashboard:** A user-friendly dashboard could be developed to visualize predictions and provide maintenance staff with actionable insights.

# REFERENCES

- Kaggle Dataset:
 https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

- Scikit-learn Documentation: https://scikit-learn.org/stable/

# GITHUB :

https://github.com/TechWithSagar/Predictive_Maintenance_Project

# IBM CERTIFICATIONS

- Screenshot/credly certificate( Getting started with AI)

In recognition of the commitment to achieve professional excellence

Getting Started with Artificial Intelligence

# Sagar Kumar

Has successfully satisfied the requirements for:

## Getting Started with Artificial Intelligence

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# IBM CERTIFICATIONS

- Screenshot/ credly certificate( Journey to Cloud)

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# IBM CERTIFICATIONS

- Screenshot/ credly certificate( RAG Lab)

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Sagar Kumar

for the completion of

**Lab: Retrieval Augmented Generation with LangChain**

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 25 Jul 2025 (GMT) **Learning hours:** 20 mins

# THANK YOU