

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

CAPSTONE PROJECT

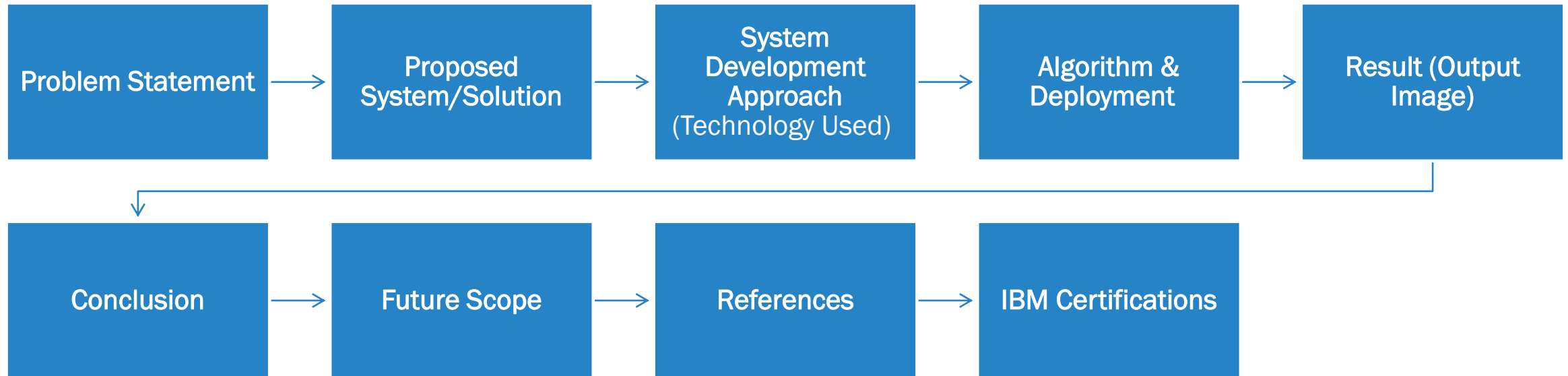
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OUTLINE



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.

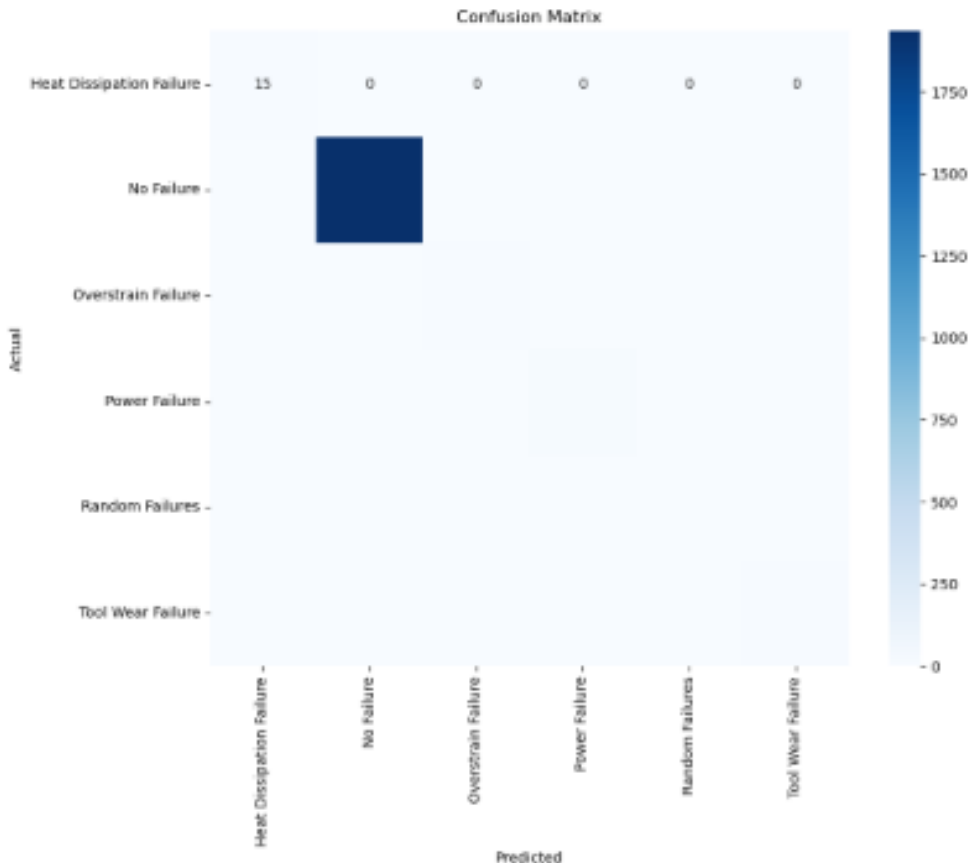


Prediction Process:

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.

RESULT

	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)



IBM CERTIFICATIONS

- Screenshot/ credly certificate(Journey to Cloud)



IBM CERTIFICATIONS

- Screenshot/ credly certificate(RAG Lab)





THANK-YOU