
CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

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OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result (Output Image)
- Conclusion
- Future Scope
- References

PROBLEM STATEMENT

Develop a predictive maintenance model for a fleet of industrial machines to anticipate failures before they occur. This project will involve analysing 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

- **Objective:** Anticipate industrial machinery failures using ML.
- **Components:**
 - **Data Collection:** Gather historical sensor data (temperature, speed, torque, tool wear) from Kaggle dataset.
 - **Data Preprocessing:** Clean data; engineer features for failure indicators.
 - **ML Model Development:** Implement classification model (e.g., Random Forest) to predict failure types.
 - **Deployment (on IBM Cloud):** Deploy model on IBM Cloud Lite services; create alerts for predictions.
 - **Evaluation:** Assess model performance using metrics (Accuracy, Precision, Recall, F1-Score).

SYSTEM APPROACH

- **Data Source:** Kaggle Predictive Maintenance Dataset (predictive_maintenance.csv).
- **Development Environment:** Python with pandas, numpy, matplotlib, seaborn, scikit-learn.
- **Cloud Platform (IBM Cloud Lite Services):**
 - **IBM Watson Studio:** For data prep, model development, and deployment.
 - **IBM Cloud Object Storage (COS):** For data and model storage.
 - **IBM Watson Machine Learning:** For model deployment and management.
 - **IBM Cloud Foundry / Code Engine:** For application logic/API endpoints.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
 - **Chosen:** Random Forest or Gradient Boosting Classifier.
 - **Justification:** Robust, handles complex sensor data, good interpretability, less prone to overfitting.
- **Data Input:** Sensor features (Air temperature, Process temperature, Rotational speed, Torque, Tool wear) and Type.
 - **Target:** Failure Type.
- **Preprocessing:** Scaling numerical features, one-hot encoding categorical features.
- **Training:** Split data, train model, hyperparameter tune, cross-validation.
- **Prediction:** Model takes real-time preprocessed sensor data, outputs predicted failure type and probabilities.
- **Deployment (IBM Cloud):**
 - Model saved and deployed as web service via IBM Watson Machine Learning.
 - Application (e.g., Flask) on IBM Cloud Foundry to interact with deployed model for alerts/dashboard.

RESULT

Service Details - IBM Cloud x IBM watsonx.ai Studio x Settings | IBM watsonx.ai Studio x +

au-syd.dai.cloud.ibm.com/ml/auto-ml/510f68ec-4a55-493d-9a73-14d5d404cf1c/train?projectId=08947998-1697-409f-ab31-46c43ded73be&context=cpdaas

Incognito (2)

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Projects / Final_Project / Predictive_Maintenance_1

Experiment summary Pipeline comparison

★ Rank by: Accuracy

Relationship map

Prediction column: Failure Type

FEATURE TRANSFORMERS

PIPELINES

TOP ALGORITHMS

predictive_mainte...

KS Karthick S Profile and settings

Log out

Experiment completed ✓

8 PIPELINES GENERATED

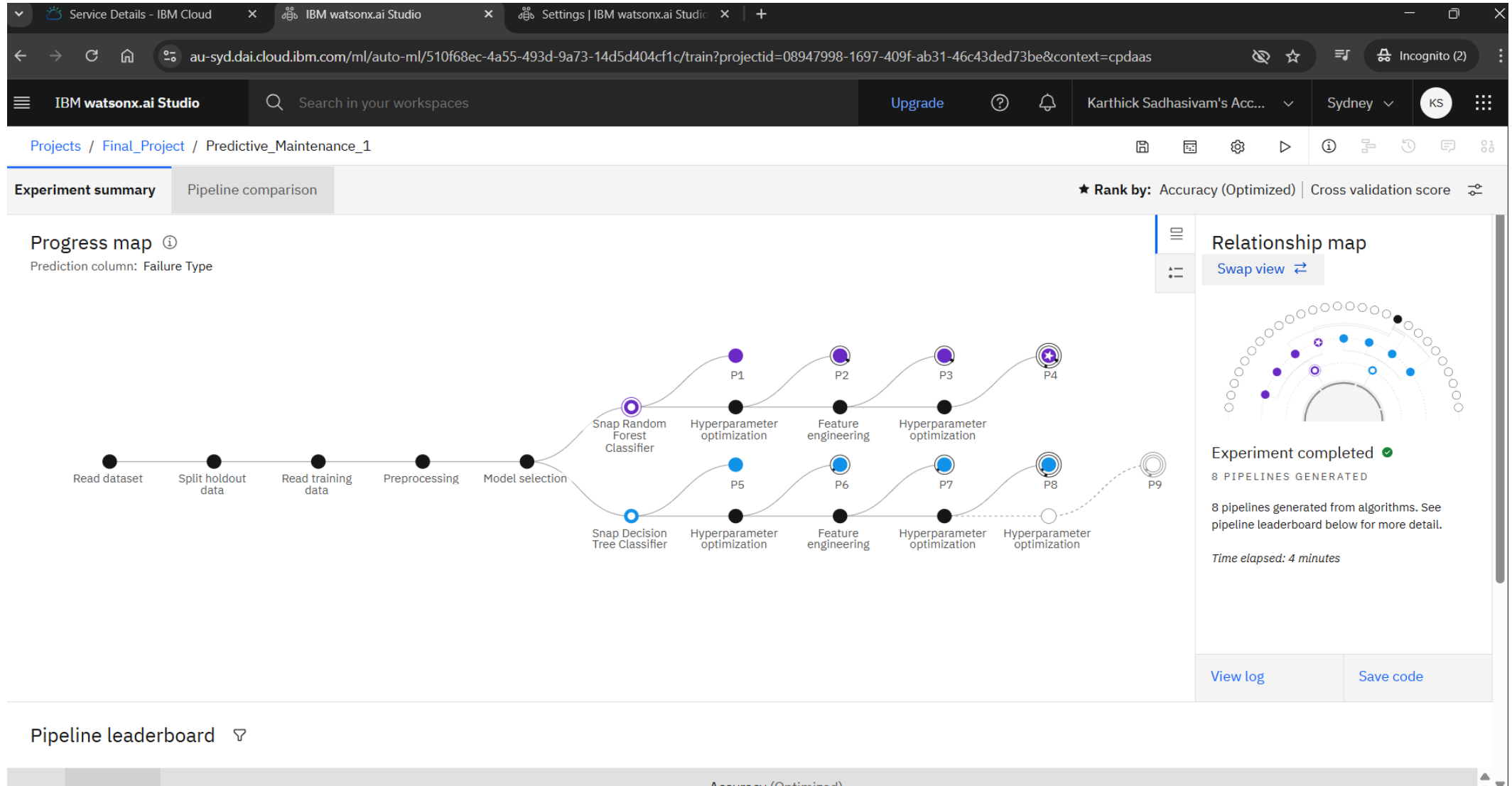
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.

Time elapsed: 4 minutes

View log Save code

Pipeline leaderboard

RESULT



RESULT

Service Details - IBM Cloud

Predictive_Maintenance_2 — P

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au-syd.dai.cloud.ibm.com/ml-runtime/deployments/8803100d-3266-4176-b529-49696a21661e/test?space_id=1da013d9-ca2a-48e3-92cc-2bb5ab0195e7&context=...

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Deployment spaces / Predictive_Maintenance / P4 - Snap Random Forest Classifier: Predictive_Maintenance_1

Predictive_Maintenance_2 ✓ Deployed Online

API reference Test

Enter input data

Text JSON

Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.

[Download CSV template](#)

[Browse local files](#)

[Search in space](#)

[Clear all](#)

	Product ID (other)	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)	Tool wear [min] (double)	Target (double)
1	L47182	L	298.1	308.5	1498	49.4	5	0
2	L47348	L	298.4	308.3	1433	62.3	20	1
3	L47422	L	298	308.2	1348	58.8	202	1
4	L47257	L	298.8	308.9	1455	41.3	208	1
5	M16081	M	297	308.3	1399	46.4	132	0
6	L51267	L	301.9	310.4	1376	54.9	126	1
7								

6 rows, 9 columns

Predict

RESULT

Service Details - IBM Cloud

Predictive_Maintenance_2 — Pr

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Pr

Prediction results

Close ×

API

Display format for prediction results

☒ Table view ☐ JSON view

☐ Show input data ⓘ

	prediction	probability
1	No Failure	[0,1,0,0,0,0]
2	Power Failure	[0,0,0,1,0,0]
3	Overstrain Failure	[0.008293461054563522,0,0.9917065620422364,0,0,-2.309680002809955e-8]
4	Tool Wear Failure	[0,0,0,0,0,1]
5	Random Failures	[0,0,4,0,0,0.6000000000000001,0]
6	Heat Dissipation Failure	[1,0,0,0,0,0]
7		
8		
9		
10		
11		
12		
13		

Download JSON file

CONCLUSION

- **Summary:** Developed and deployed a predictive maintenance model on IBM Cloud, successfully anticipating machinery failures from sensor data.
- **Effectiveness:**
 - Reduced Downtime & Operational Costs.
 - Improved Efficiency & Enhanced Safety.
- **Challenges:** Data quality, class imbalance, real-time inference optimization, IBM Cloud integration.
- **Improvements:** Incorporate more data, explore deep learning, develop advanced UI.

FUTURE SCOPE

- **IoT Integration:** Direct integration with IoT sensors for real-time data streaming.
- **Multi-Machine Fleet Management:** Expand to large, heterogeneous fleets, potentially using edge computing.
- **Prescriptive Maintenance:** Recommend specific actions and optimal scheduling.
- **Reinforcement Learning:** Optimize maintenance schedules dynamically.
- **Anomaly Detection:** Identify novel failure modes.
- **Scalability & Robustness:** Optimize for enterprise-level deployment.
- **Enterprise System Integration:** Seamlessly integrate with ERP/CMMS.

REFERENCES

- Kaggle Dataset: Shivam Bansal. (2021). Predictive Maintenance Dataset. Kaggle. <https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification>
- Documentation for scikit-learn, pandas, numpy.
- IBM Cloud documentation (Watson Studio, COS, Watson Machine Learning).

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This certificate is presented to

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According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins



THANK YOU