CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:

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GITHUB LINK:

https://github.com/jayakumartkofficial/Machine_Fault_Prediction_Using_ML

OUTLINE

- **Problem Statement**
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **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 analyzing 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

- Develop a machine learning model for **predictive maintenance** using real-time sensor data to detect failures (e.g., tool wear, overheating, power issues) **before they happen.** This enables proactive maintenance and reduces downtime.
- Key Components:
- **Data Collection:** Gather time-series sensor data from a **fleet of industrial machines**, including operational logs such as Air temperature [K] Process temperature [K] Rotational speed [rpm] Torque [Nm] Tool wear [min],Target.
- **Data Preprocessing:** Clean, normalize, and standardize data; handle missing values and noise. **.**
- **Model Training: Snap Random Forest Classifier, Snap Decision Tree Classifier.**
  Apply: **Hyperparameter optimization** and **Feature engineering**
- **Evaluation:** Measure performance using accuracy, precision, recall, and F1-score.
  Final models (**P4** and **P8**) selected based on best metric
- **Result:** Snap Random Forest Classifer and Snap Decision Tree models accurately predicted machine failures, with P4 and P8 selected for real-time deployment.

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SYSTEM APPROACH

- **System requirements :**
- IBM Cloud (Mandatory),IBM Watson.ai Studio for model development and deployment,
- IBM Cloud Object Storage for dataset handling, Watsonx Runtime for running and managing models
- **Steps:**
- Log in to IBM Cloud → Search **watsonx.ai studio** → Select server → Create new project and storage.
- In project: **Associate watsonx.ai Runtime** via *Manage* > *Services & Integrations*.
- Click **Build ML model automatically** → Upload dataset → Select target column → Allow AutoAI to analyze.
- Save best model → Promote to deployment space → Create deployment → Run & view prediction output.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
- **Random Forest Classifier:** A model that uses many decision trees to make better and more accurate predictions. It works well for classifying data and is more reliable than using just one tree
- **Snap Decision Tree Classifier:** An optimized, faster version of the decision tree used in IBM AutoAI. It provides quick, accurate predictions with minimal computation time.
- **Data Input:** Input features include **Process temperature (K)**, **Rotational speed (rpm)**, **Torque (Nm)**, **Tool wear (min)**, and **machine failure types** like Power Failure, Overstrain failure, Tool wear Failure. Trained in **Watsonx.ai** using **IBM AutoAI**, leveraging automated preprocessing, feature selection, and hyperparameter tuning on labelled failure data.It classifies the failure type in advance, enabling timely alerts and **proactive maintenance actions**
- DEPLOYMENT:
- **Save and promote** the best model to a deployment space.
- **Create a deployment** by naming and selecting the model.
- **Run predictions** using the deployed model or connect via API.

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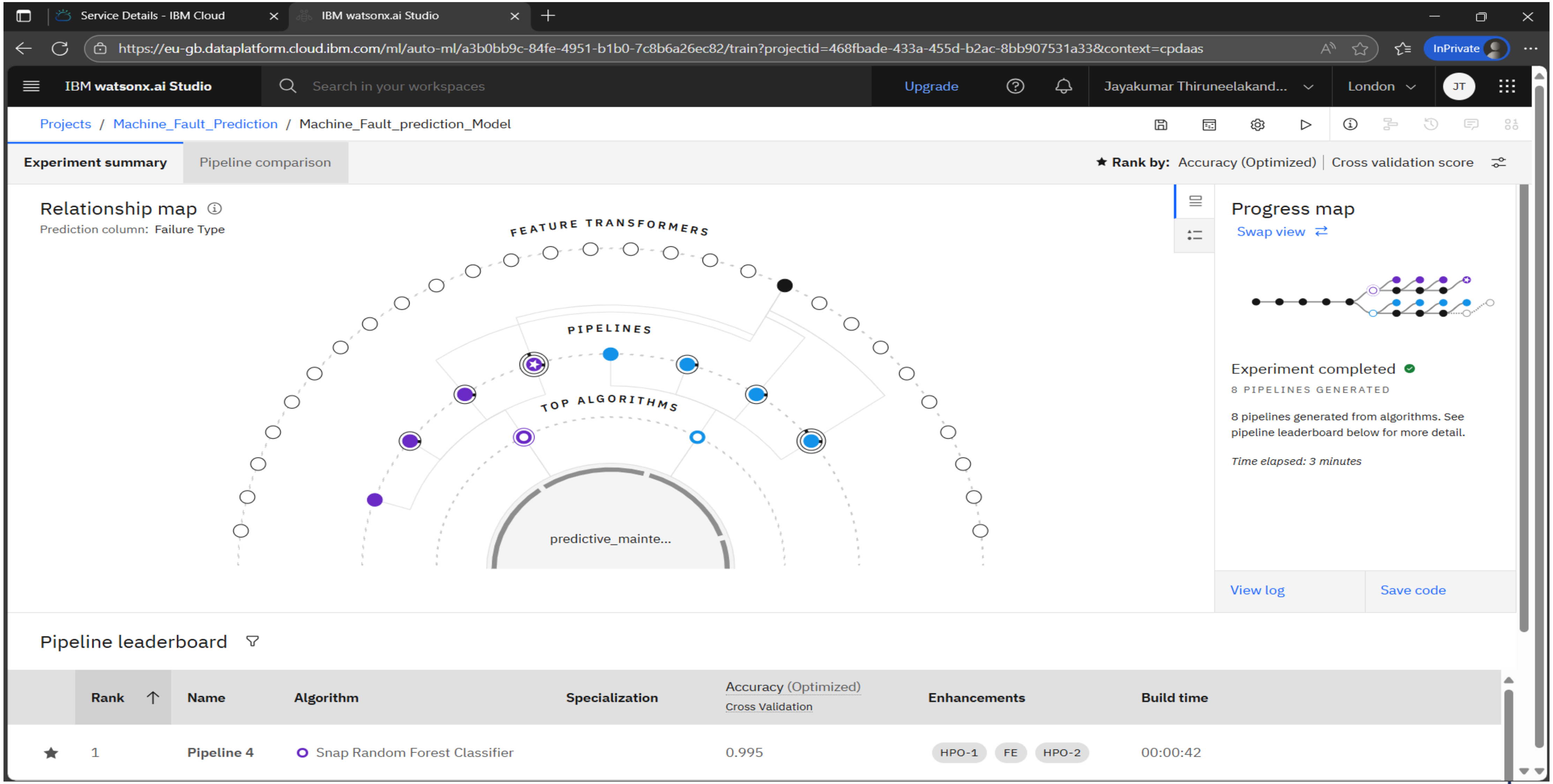
RESULT



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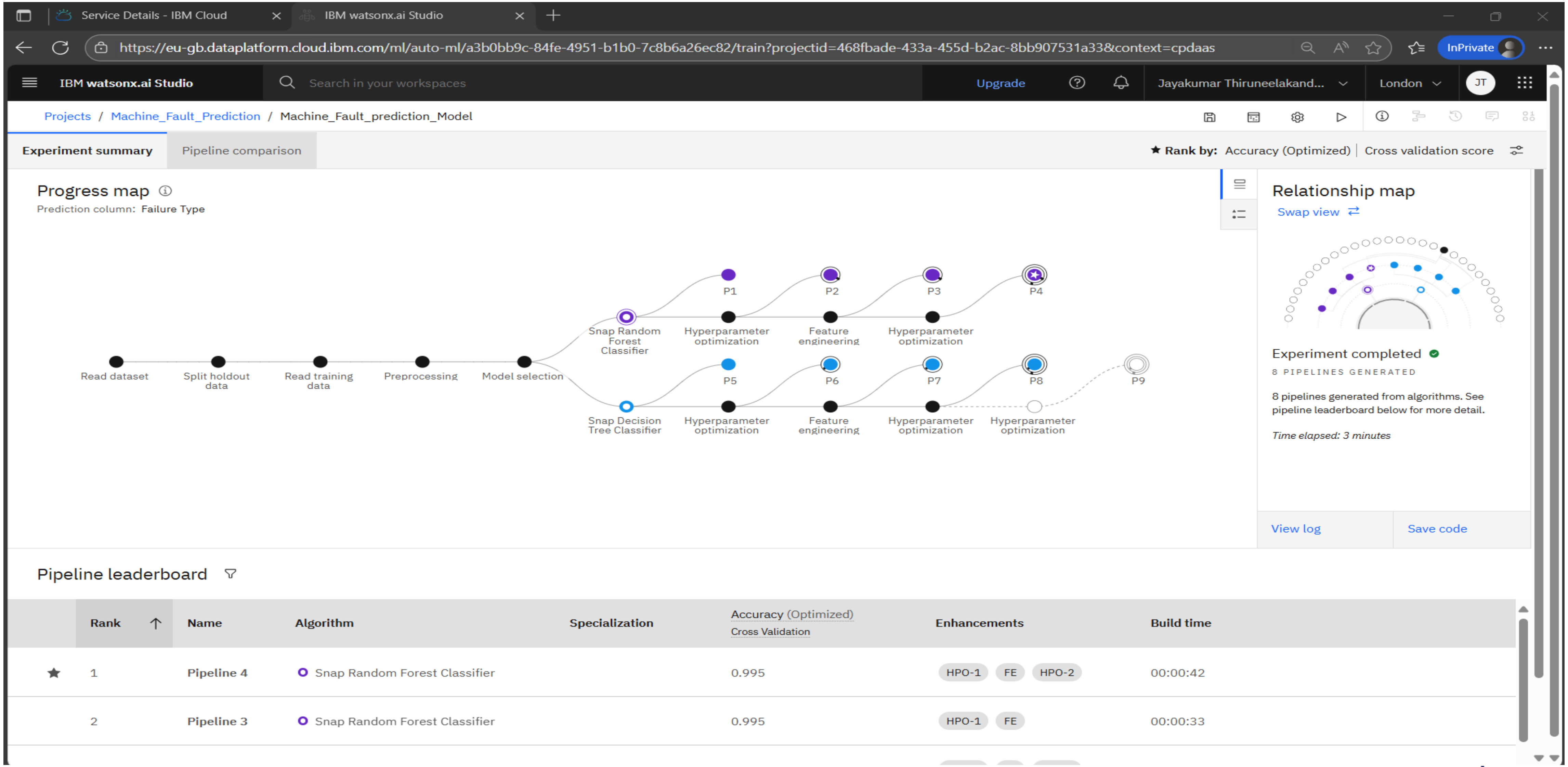
RESULT



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RESULT

Service Details - IBM Cloud | MachineFaultPrediction_Online_D

https://eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/f968c6dc-037c-4236-b19b-17815f5d7735/test?space_id=3b261a58-8524-4586-82f4-795620ba7f3e&context=cpda...

InPrivate

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Jayakumar Thiruneelakand... | London | JT

Deployment spaces / Machine_Fault_Prediction_Deployment / P4 - Snap Random Forest Classifier: Machine_Fault_prediction_Model /

MachineFaultPrediction_Online_Deployment

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

	UDI (double)	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	1	M14860	M	298.1	308.6	1551	42.8	0	0
2	70	L47249	L	298.8	309	1410	65.5	191	1
3	78	L47275	L	298.8	308.9	1455	41.3	208	1
4	161	L47340	L	298.4	308.2	1282	60.7	216	1
5	876	M15735	M	295.8	306.3	1444	45.5	76	0
6	45	M149404	M	298.8	309.1	1472	47.5	125	0
7	10	M1429	M	298.5	309	1741	28	21	0
8	18	M14877	M	298.7	309.2	1410	45.6	47	0
9	174	M15033	M	298.2	308	1591	33.7	32	0
10	328	L47507	L	29.7	308.5	1373	56.7	203	1
11									

10 rows, 9 columns

Predict

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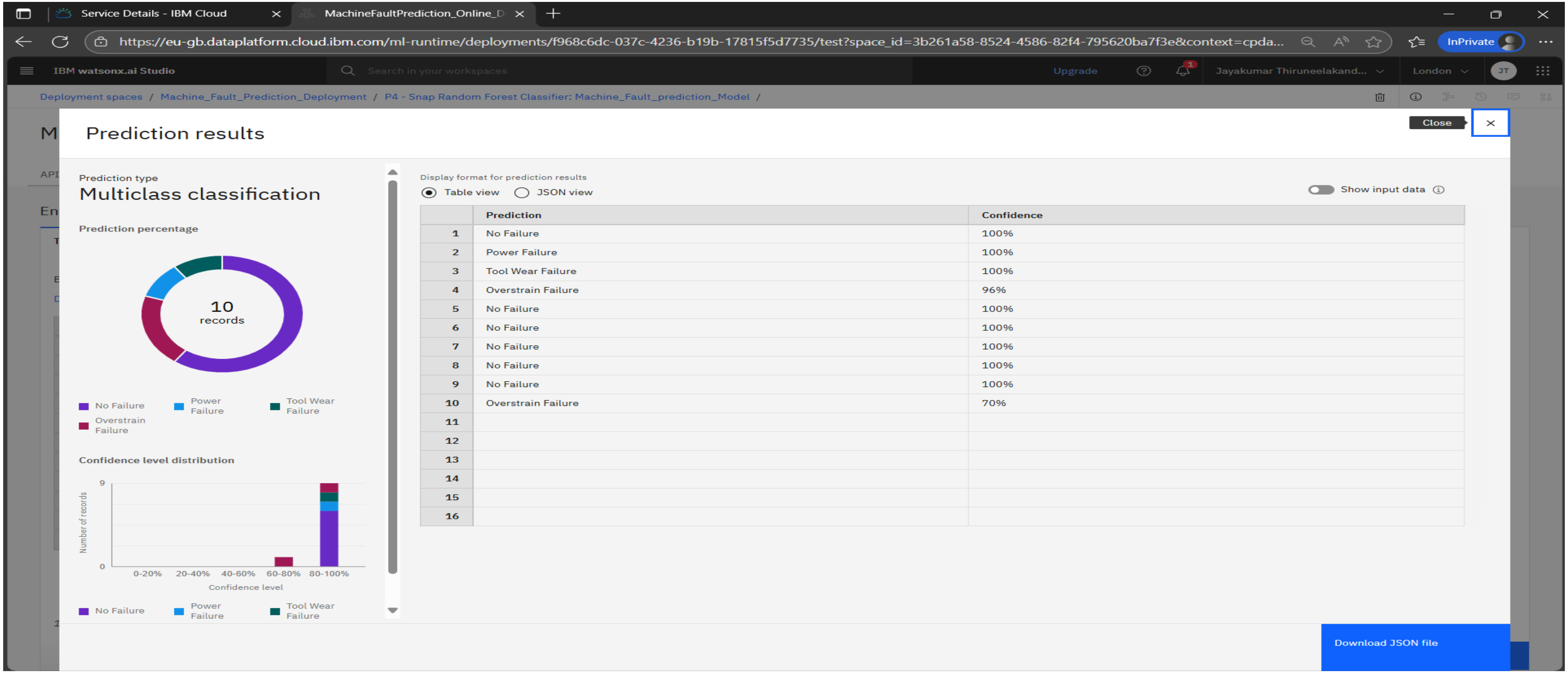
RESULT



	Prediction	Confidence
1	No Failure	100%
2	Power Failure	100%
3	Tool Wear Failure	100%
4	Overstrain Failure	96%
5	No Failure	100%
6	No Failure	100%
7	No Failure	100%
8	No Failure	100%
9	No Failure	100%
10	Overstrain Failure	70%
11		
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16		

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CONCLUSION

- A robust predictive maintenance model was developed using **IBM Watson Studio** and **Watsonx.ai AutoAI**, which automated the entire machine learning pipeline—from data preprocessing to model optimization.
- The model utilizes real-time and historical machine data to classify failure types like tool wear, heat dissipation, power failure with high accuracy.
- By enabling **early failure detection**, the solution helps reduce **unplanned downtime**, extend **machine life**, and improve **operational reliability** across industrial systems.
- The no-code AutoAI environment made it possible to build and deploy the solution efficiently, making it scalable for industrial applications.

FUTURE SCOPE

- The predictive maintenance model can be enhanced by integrating **additional real-time sensor data** and **operational parameters** to better capture early signs of failures such as tool wear, heat dissipation issues, or power faults.
- Integration with **automated alert systems** and **maintenance management platforms** can further streamline repair processes and reduce unexpected downtime.

REFERENCES

1. **IBM Think – Predictive Maintenance Overview**
   Explains how IBM uses AI and IoT to predict equipment failures and reduce unplanned downtime link: click_here
2. **IBM Research – Event Log-Based Failure Prediction**
   Case study showing how IBM applies machine learning to operational machine logs for maintenance insights.link: click_here
3. **Applied Sciences (MDPI) – Review on Predictive Maintenance Techniques**
   Academic survey discussing machine learning models (including deep learning) for industrial failure prediction. link: click_here

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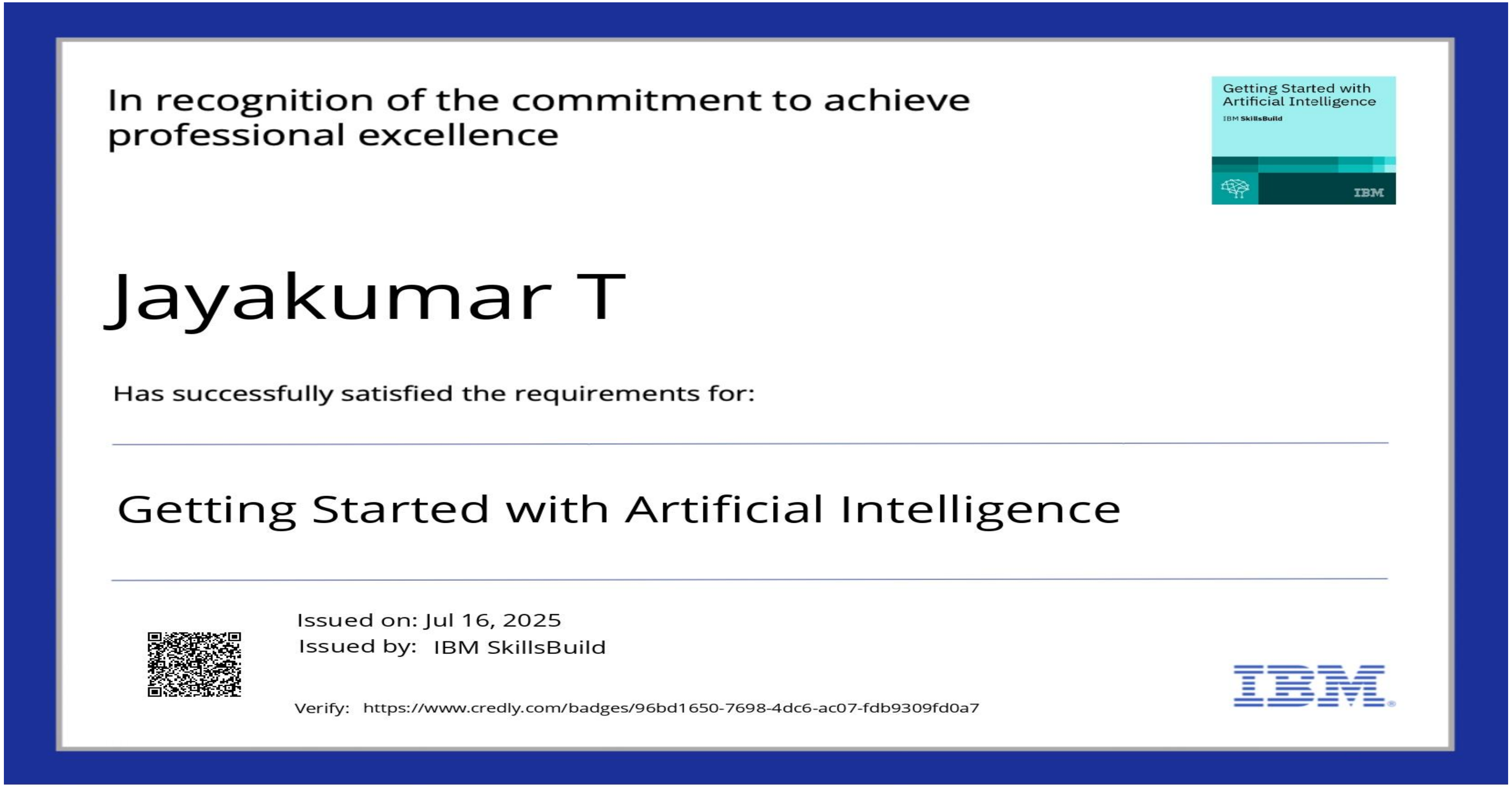
IBM CERTIFICATIONS

Getting Started With Ai Certificate



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According to the Adobe Learning Manager system of record

Completion date: 23 Jul 2025 (GMT)

Learning hours: 20 mins

THANK YOU