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# **CAPSTONE PROJECT**

## **PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY**

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# OUTLINE

- **Problem Statement**
- **Proposed System/Solution**
- **System Development Approach**
- **Algorithm & Deployment**
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# PROBLEM STATEMENT

## **Predictive Maintenance of Industrial Machinery**

- 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.

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# PROPOSED SOLUTION

- **Sensor Data Collection:**

Collect real-time and historical sensor data from industrial machines, including parameters such as temperature, torque, speed, and tool wear.

- **Data Preprocessing:**

Clean and preprocess the data to handle missing values and outliers. Apply normalization and feature encoding as needed.

- **Feature Engineering:**

Extract meaningful features from raw sensor inputs that contribute to machinery failures (e.g., tool wear thresholds, speed anomalies).

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# PROPOSED SOLUTION

- **Machine Learning Model:**

Utilize IBM AutoAI to automatically test, tune, and select the best classification model (e.g., Random Forest) for predicting failure types.

- **Deployment:**

Deploy the best-performing model using IBM Watsonx.ai Studio. Enable users to input real-time machine data and get instant failure predictions.

- **Evaluation:**

Assess model accuracy using cross-validation metrics (Accuracy: 99.5%). Continuously monitor and retrain if needed for improved reliability.

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# SYSTEM APPROACH

The System Approach outlines the technical environment and tools used to build the predictive maintenance system.

## System Requirements

### Software:

- IBM Cloud account
- IBM Watsonx.ai Studio
- IBM Cloud Object Storage
- Watson Online Deployment

### Input Data:

Industrial sensor data (CSV format) which includes features such as Air Temp, Process Temp, Torque, Speed, Tool Wear, etc.

### Output:

Predicted machine failure type (e.g., No Failure, Heat Dissipation, Power Failure)

# ALGORITHM & DEPLOYMENT

## Algorithm Used:

- **Snap Random Forest Classifier**
- It has high accuracy (99.5%) , Robust with structured sensor data ,Good for multi-class classification ,Handles complex relationships between features

## Input Features:

- Product Name, Machine Type, Air & Process Temperature, Rotational Speed, Torque, Tool Wear etc.

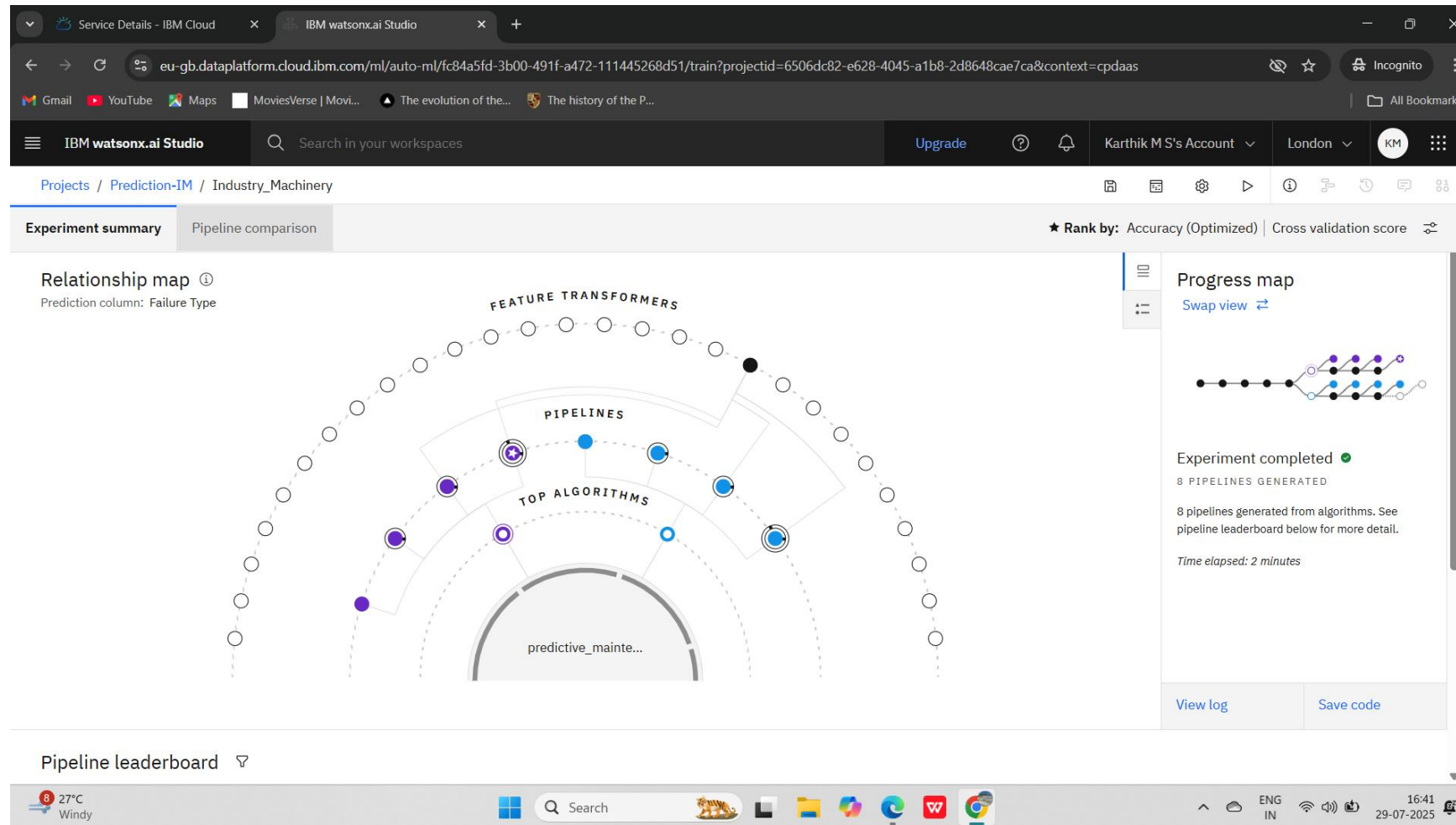
## Training Process:

- AutoAI handled preprocessing, feature engineering, and model tuning
- Used cross-validation and hyperparameter optimization (HPO)

## Prediction:

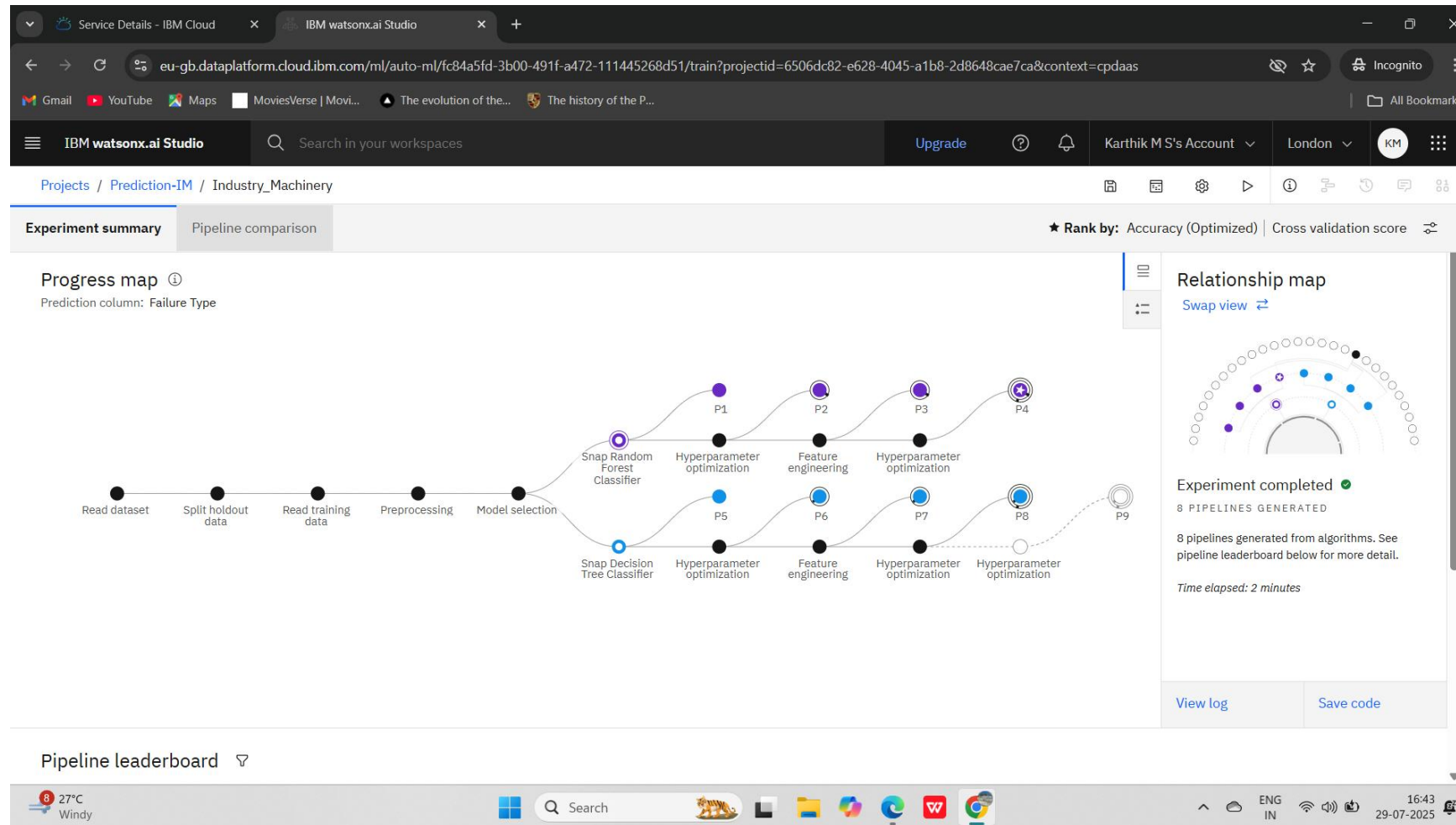
- Real-time failure type prediction
- Deployed on IBM Cloud for live input and output

# RESULT





# RESULT



# RESULT

The screenshot displays the IBM watsonx.ai Studio web interface. The browser address bar shows the URL: `eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/fc84a5fd-3b00-491f-a472-111445268d51/train?projectId=6506dc82-e628-4045-a1b8-2d8648cae7ca&context=cpdaas`. The interface includes a top navigation bar with the IBM watsonx.ai Studio logo, a search bar, and user account information for Karthik M S's Account. Below the navigation bar, the breadcrumb trail indicates the current location: `Projects / Prediction-IM / Industry_Machinery`. The main content area is divided into two tabs: `Experiment summary` (active) and `Pipeline comparison`. The `Experiment summary` tab displays a `Rank by: Accuracy (Optimized)` filter and a `Cross validation score` section. A `Time elapsed: 2 minutes` message is shown. Below this, the `Pipeline leaderboard` is displayed, featuring a table with the following columns: `Rank`, `Name`, `Algorithm`, `Specialization`, `Accuracy (Optimized) Cross Validation`, `Enhancements`, and `Build time`. The table lists four pipelines, with Pipeline 4 at the top rank. The Windows taskbar at the bottom shows the system clock as 16:43 on 29-07-2025, along with weather information (27°C Windy) and various application icons.

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

eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/fc84a5fd-3b00-491f-a472-111445268d51/train?projectId=6506dc82-e628-4045-a1b8-2d8648cae7ca&context=cpdaas

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Projects / Prediction-IM / Industry\_Machinery

Experiment summary Pipeline comparison

★ Rank by: Accuracy (Optimized) | Cross validation score

Time elapsed: 2 minutes

View log Save code

Pipeline leaderboard

	Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 4	Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:00:39
	2	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:30
	3	Pipeline 8	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:30
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:08

27°C Windy Search 16:43 29-07-2025

# RESULT

Service Details - IBM Cloud x IM-Prediction — Machinery\_Fai x +

eu-gb.dataplatfrom.cloud.ibm.com/ml-runtime/deployments/2385af9c-f7d2-4347-a974-8ae3a209c577/test?space\_id=53d34770-ef79-4bbd-8749-84aee9784405&context=cpdaas&flus... Incognito

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Deployment spaces / Machinery\_Fault\_Prediction / P4 - Snap Random Forest Classifier: Industry\_Machinery /

## IM-Prediction ✓ 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](#) x

	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)	Tool wear [min] (double)	Target (double)
1	L	290.5	400.1	1553	45.9	0	0
2	L	270.6	280.5	1441	36.2	54	1
3	M	315.8	300.7	1523	40.5	12	0
4	L	309.5	350	1365	46.8	25	1

8 rows, 9 columns

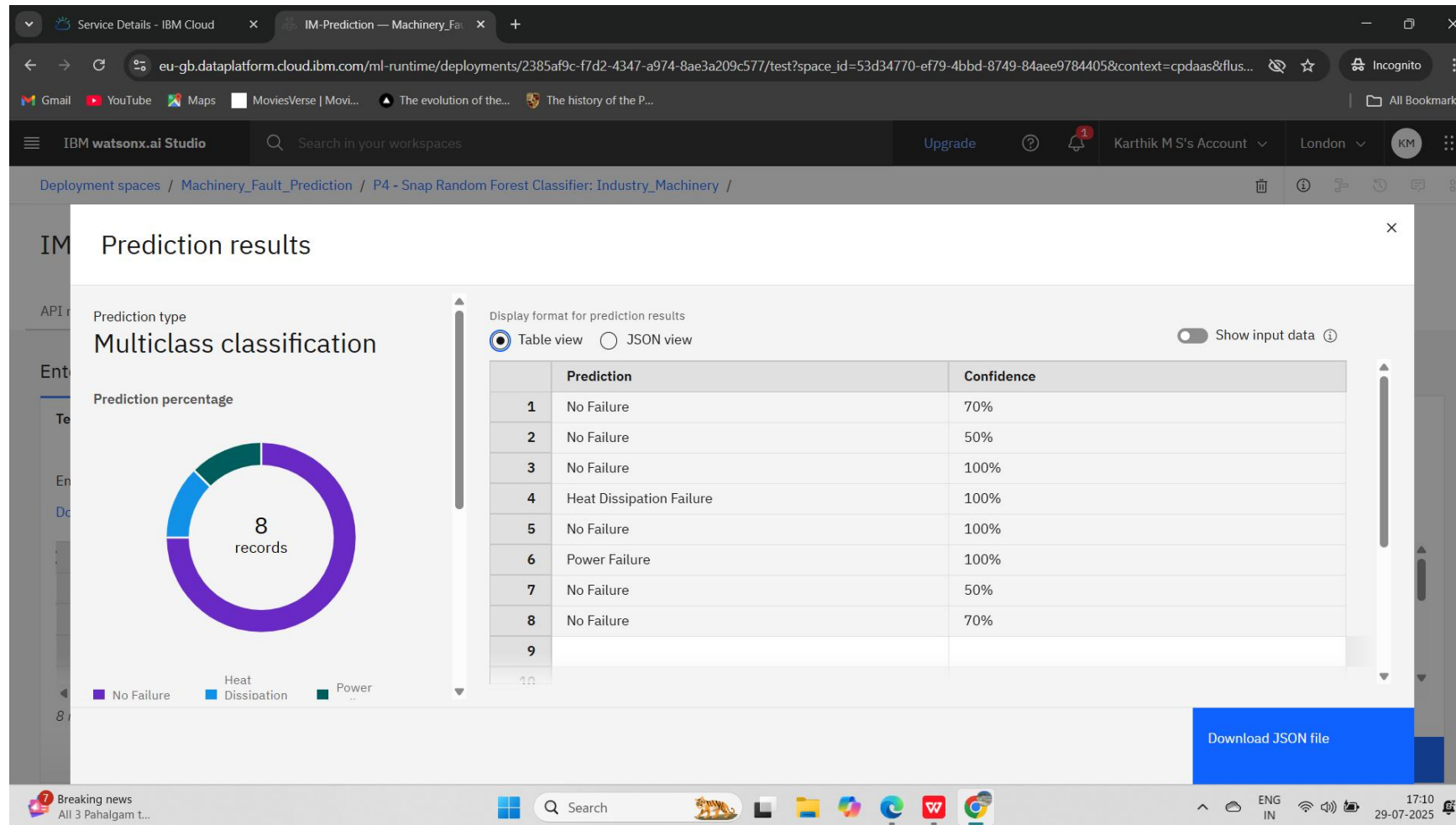
Predict

# RESULT

## Test data

UDI	Product ID	Type	Air tempera	Process terr	Rotational s	Torque [Nm	Tool wear [i	Target
1	L58642	L	290.5	400.1	1553	45.9	0	0
2	L89421	L	270.6	280.5	1441	36.2	54	1
3	M98723	M	315.8	300.7	1523	40.5	12	0
4	L15489	L	309.5	350	1365	46.8	25	1
5	M36478	M	296.1	309	1523	36.9	24	0
6	L47230	L	298	309	2861	4.6	143	1
7	M25846	M	309.2	299	1400	43.7	19	1
8	H73485	H	320.7	290	1652	38.5	13	1

# RESULT



# CONCLUSION

- Achieved 99.5% accuracy in predicting machine failures using IBM AutoAI.
- Enabled proactive maintenance, reducing machine downtime and operational costs.
- Ensured accurate classification of different failure types (e.g., tool wear, power failure).
- Faced challenges in understanding AutoAI workflow and interpreting multi-class predictions.
- Demonstrated the effectiveness of AI in improving industrial machinery reliability.

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## FUTURE SCOPE

- Add more data sources like vibration and maintenance logs.
- Use advanced ML models for better performance.
- Expand the system to multiple factories or regions.
- Explore deep learning and edge computing for real-time predictions.
- Build a dashboard with live alerts for maintenance teams.

# REFERENCES

Kaggle Dataset:

Machine Predictive Maintenance Classification Dataset

<https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification>

IBM Documentation:

IBM Watsonx.ai – AutoAI User Guide

<https://www.ibm.com/docs/en/watsonx>

IBM AutoAI Overview

<https://www.ibm.com/cloud/watson-studio/autoai>



# IBM CERTIFICATIONS

In recognition of the commitment to achieve  
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# IBM CERTIFICATIONS

IBM **SkillsBuild**

Completion Certificate



This certificate is presented to

Karthik M S

for the completion of

**Lab: Retrieval Augmented Generation with  
LangChain**

(ALM-COURSE\_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 24 Jul 2025 (GMT)

**Learning hours:** 20 mins



**THANK YOU**