CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:
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OUTLINE

- **Problem Statement** (Should not include solution)
- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
- **Algorithm & Deployment**
- **Result (Output Image)**
- **Conclusion**
- **Future Scope**
- **References**

PROBLEM STATEMENT

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

To build a **machine learning classification model** that predicts the **type of machine failure** (e.g., tool wear, heat dissipation, power failure, etc.) using real-time **sensor data**. This enables **proactive maintenance**, minimizing **unexpected downtimes** and **reducing operational costs**.

- **Key Components**

1. Data Collection: Collect real-time operational and sensor data (e.g., temperature, speed, torque, tool wear) from the Kaggle dataset.

2. Data Pre-processing: Clean the data, handle missing values, normalize features, and encode categorical variables for model readiness.

3. Machine Learning Algorithm: Apply classification algorithms like Random Forest, SVM, or Gradient Boosting to predict the type of machine failure.

4. Evaluation: Evaluate model performance using accuracy, precision, recall, F1-score, and confusion matrix.

5. Deployment: Deploy the trained model using IBM Cloud Lite's Watson Studio or Code Engine for real-time predictions.

SYSTEM APPROACH

The "System Approach" outlines the structured methodology used to develop an intelligent predictive maintenance system for industrial machinery. The objective is to build a machine learning model that can accurately predict different types of machine failures using real-time sensor data, enabling proactive maintenance and minimizing unexpected downtime. The development process includes the following stages:

System Requirements

- IBM Cloud (Mandatory)
- IBM Watson Studio for Model Development and Deployment
- IBM Cloud Object Storage for Dataset Handling

ALGORITHM & DEPLOYMENT

- **Algorithm Selection**

  We use the **Random Forest Classifier** for its accuracy and ability to handle complex data.
  It's robust against overfitting and works well with sensor-based classification tasks.

- **Data Input**

  Sensor data such as temperature, torque, speed, and tool wear are collected from machines.
  These values are preprocessed and used as inputs for model training and prediction.

- **Training Process**

  The cleaned and normalized dataset is split into training and testing sets.
  The model is trained to classify failure types and evaluated using accuracy and F1-score.

- **Prediction Process**

  Model Deployed on IBM Watson Studio With API End Point for Real Time Predictions.

- **Deployment**

  The final model is deployed using **IBM Watson Studio**.
  An API endpoint is created so external systems can send data and get live predictions.

RESULT

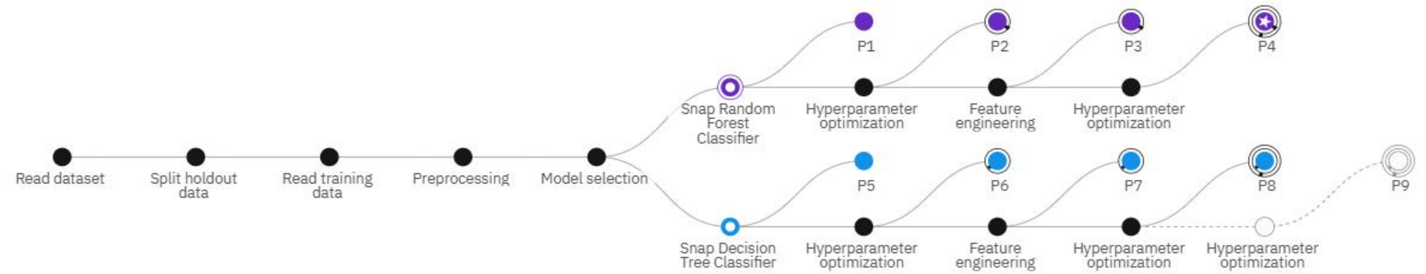
Projects / Machinery_Predit / Machinery_Problem_Predict

Experiment summary | Pipeline comparison

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

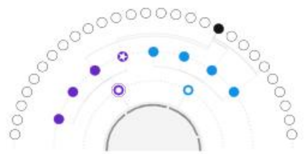
Progress map

Prediction column: Failure Type



Relationship map

Swap view ⇄



Experiment completed

8 PIPELINES GENERATED

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

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	00:00:37
	2	**Pipeline 3**	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:29

RESULT

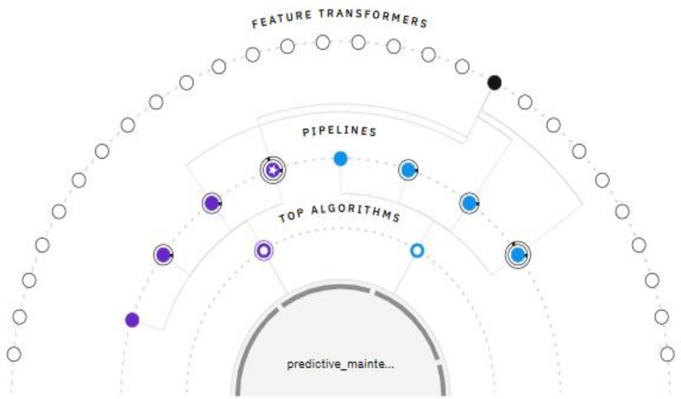
Projects / Machinery_Predit / Machinery_Problem_Predict

Experiment summary | Pipeline comparison

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

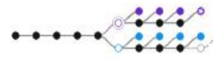
Relationship map ⓘ

Prediction column: Failure Type



Progress map

Swap view ⇄



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	2	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:29
	3	Pipeline 8	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:28
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:07
	5	Pipeline 1	Snap Random Forest Classifier		0.994	*None*	00:00:02
	6	Pipeline 7	Snap Decision Tree Classifier		0.993	HPO-1 FE	00:00:24

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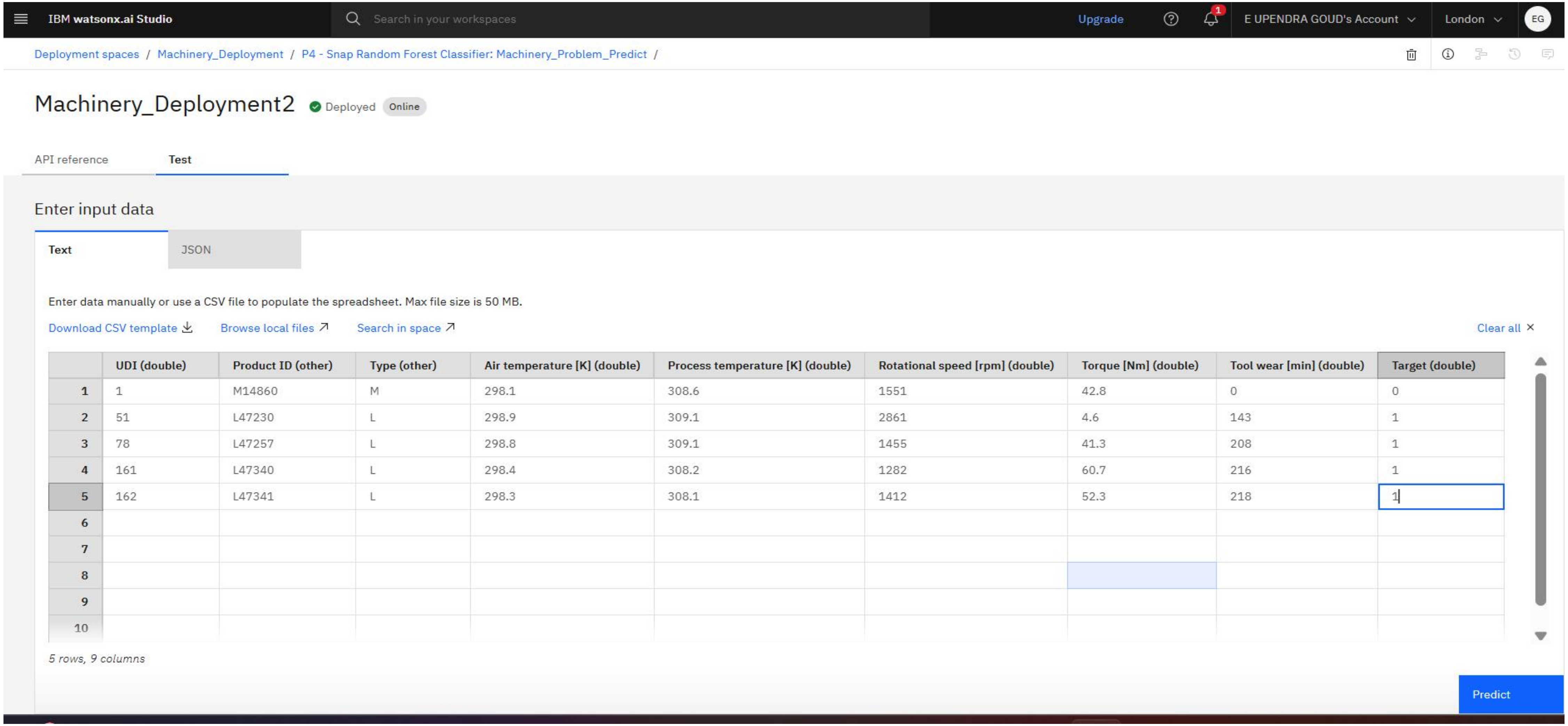
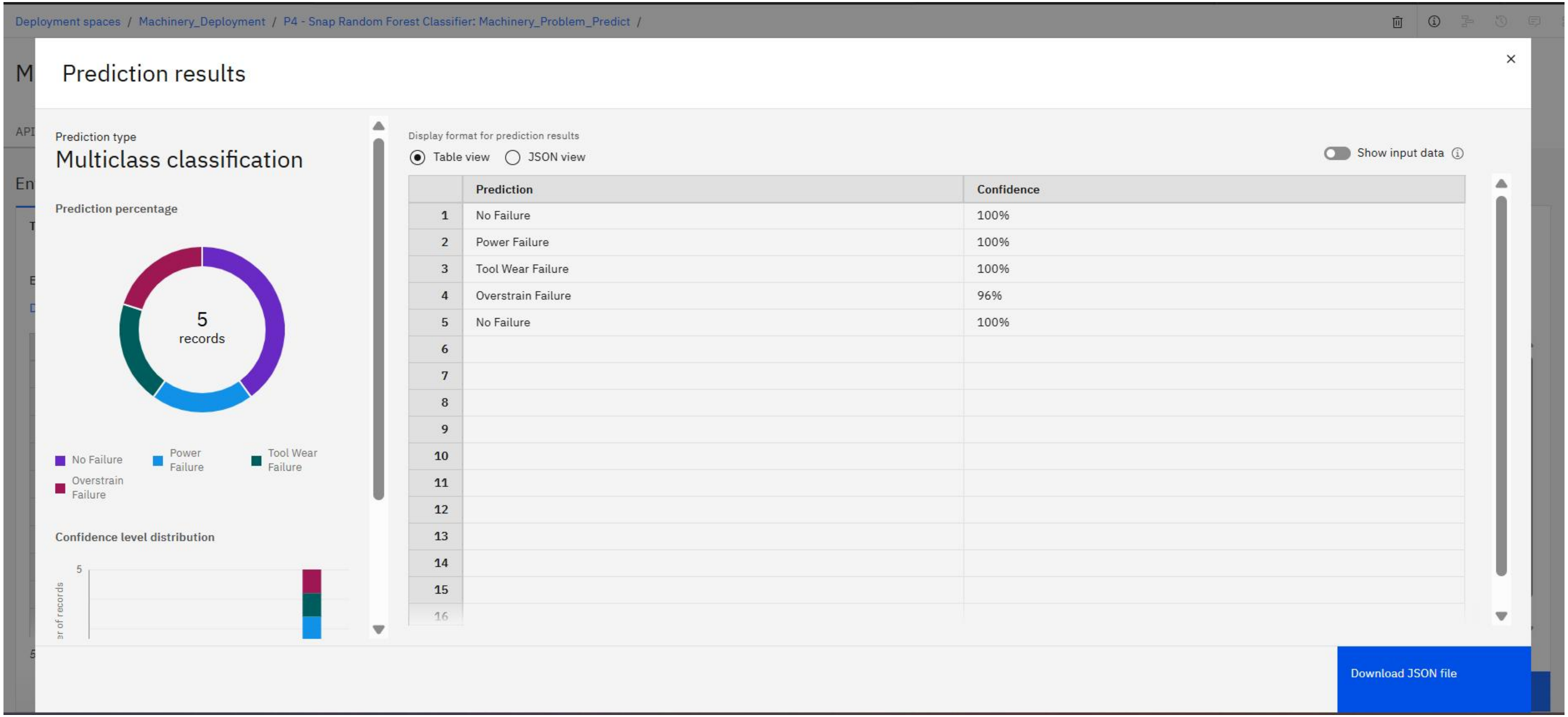
RESULT



	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	51	L47230	L	298.9	309.1	2861	4.6	143	1
3	78	L47257	L	298.8	309.1	1455	41.3	208	1
4	161	L47340	L	298.4	308.2	1282	60.7	216	1
5	162	L47341	L	298.3	308.1	1412	52.3	218	1
6									
7									
8									
9									
10									

RESULT



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CONCLUSION

- The project successfully developed a machine learning-based predictive maintenance system capable of identifying and classifying various types of industrial machinery failures such as tool wear, heat dissipation issues, Overstrain Failure and power failures. By analyzing real-time sensor data, the proposed solution demonstrated high accuracy in detecting failure patterns, enabling timely and proactive maintenance actions.
- The implementation proved effective in reducing unexpected machine downtimes and improving overall equipment reliability. During development, challenges such as imbalanced failure classes and noise in sensor readings were encountered. These were mitigated through appropriate preprocessing, feature selection, and model tuning techniques.

FUTURE SCOPE

The predictive maintenance system can be enhanced by integrating real-time IoT sensor data, enabling instant fault detection and response. Expanding the model to use multimodal data such as vibration and acoustic signals can improve accuracy. Deploying the solution at scale across different industries and machines, incorporating edge computing for faster on-site predictions, and developing self-learning models that adapt over time are key future directions. Additionally, the solution can be offered as a cloud-based Predictive Maintenance as a Service (PMaaS) to support industrial automation and digital transformation.

REFERENCES

IBM Skills Build Learning Platform
AI Foundations: Machine Learning, Natural Language Processing, and Deep Learning Modules.
Provided by IBM in collaboration with Edunet Foundation and AICTE under the IBM SkillsBuild Internship Program.
https://skillsbuild.org

IBM Cloud Documentation
Deploying AI Models with IBM Watson Studio and IBM Code Engine.
IBM Cloud Docs, 2024.
https://cloud.ibm.com/docs

Edunet Foundation – IBM Internship Curriculum
Journey to Cloud and Introduction to AI & Machine Learning.
Internship material provided as part of the 4-week internship on AI & Cloud Technologies, 2025.

REFERENCES

Kaggle Dataset – Predictive Maintenance
Shivam Bansal. *“Machine Predictive Maintenance Classification Dataset.”*
https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

Scikit-learn Documentation
Model Evaluation Metrics for Classification Algorithms.
https://scikit-learn.org/stable/modules/model_evaluation.html

Note:
The theoretical knowledge and hands-on skills gained through IBM’s AI and Cloud certification programs helped guide the successful implementation of this machine learning project.

IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

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IBM **SkillsBuild** Completion Certificate

This certificate is presented to

E Upendra Goud

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 23 Jul 2025 (GMT)

Learning hours: 20 mins

THANK YOU