IBM SKILLSBUILD – AICTE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:
1.Surada Guna Sekhar - SAGI RAMAKRISHNAM RAJU
ENGINEERING COLLEGE - Computer Science and Engineering

edunet foundation

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

- Industrial machinery often encounters **unexpected failures** such as **tool wear, heat dissipation issues, power failures, and overstrain**, which lead to **unplanned downtime, high maintenance costs, and reduced productivity.** Traditional maintenance approaches are largely **reactive**, addressing failures only after they occur, resulting in significant operational inefficiencies. The core challenge is to **anticipate these failures in advance** by identifying patterns that indicate potential breakdowns, allowing industries to **minimize downtime, reduce costs, and enhance machine reliability.**

PROPOSED SOLUTION

- Data Collection:
- Collected **Kaggle Predictive Maintenance dataset** with **5 key sensor readings**.
- Captured machine conditions and historical failure records.
- Data Preprocessing:
- **Cleaned missing values** and **removed outliers**.
- Applied **feature engineering** and **PCA transformation** to optimize model performance.
- Machine Learning Algorithm:
- Utilized **IBM Watson AutoAI on IBM Cloud Lite** to generate **9 ML pipelines**.
- Selected **Batched Tree Ensemble Classifier (Snap Random Forest)** as best model.
- Deployment:
- Deployed trained model on **IBM Cloud Lite** as a **real-time endpoint** for predictive maintenance.
- Evaluation:
- Achieved **99.7% accuracy**, high precision/recall, and **minimal misclassifications**.

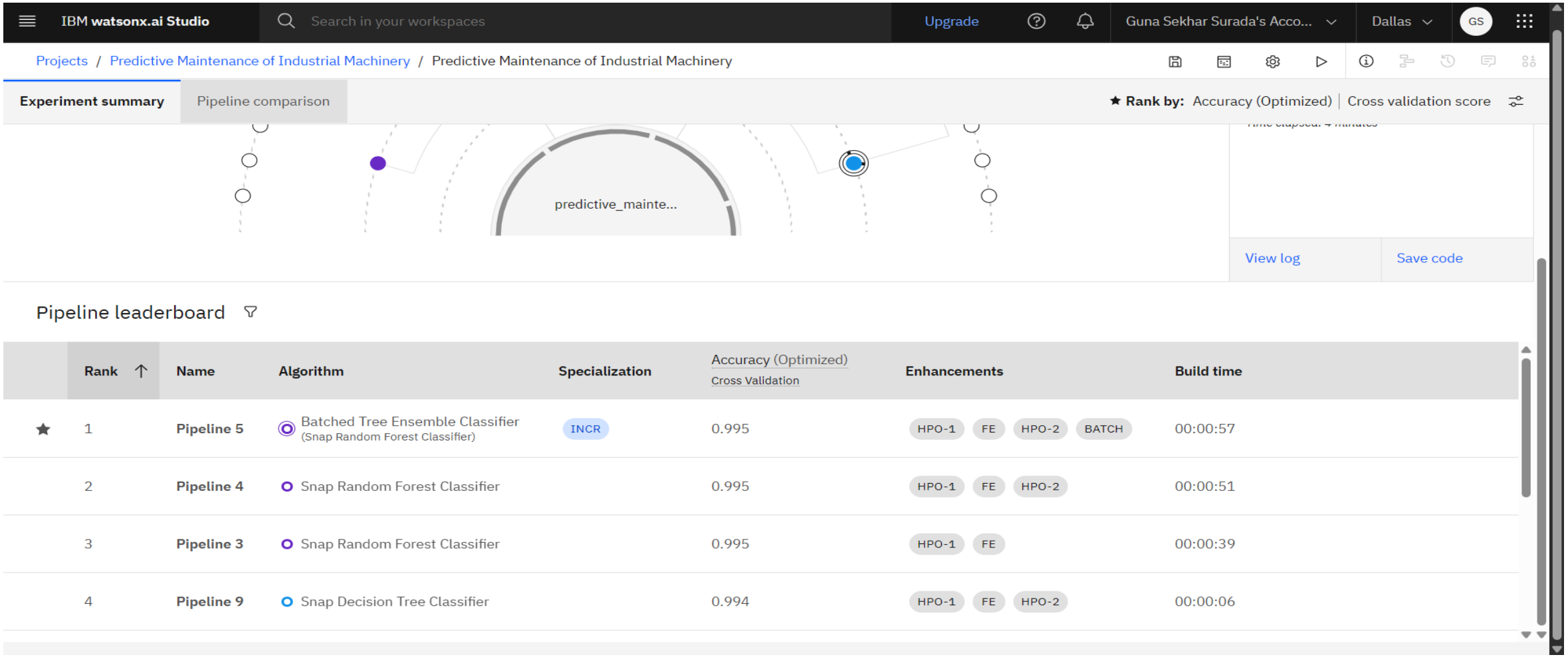
SYSTEM APPROACH

- System requirements:
- **Platform:** IBM Cloud Lite (Watson Studio & AutoAI)
- **Dataset:** Kaggle – Machine Predictive Maintenance Classification
- **Compute Environment:** Cloud-based AutoAI pipelines (no local execution)
- **Deployment:** IBM Cloud Lite real-time endpoint for predictive maintenance
- Library required to build the model:
- **IBM AutoAI (built-in ML pipelines)** – handles preprocessing, model selection, and hyperparameter tuning automatically
- **Python (Cloud Environment)** – used for minor preprocessing in notebooks
- **Internal libraries used by AutoAI pipelines**:
  - **scikit-learn** (classification & evaluation)
  - **xgboost** and **lightgbm** (boosted ensemble methods)

ALGORITHM & DEPLOYMENT

- Algorithm Selection:
- **Batched Tree Ensemble Classifier (Snap Random Forest)** chosen for its **high accuracy and reliability.**
- Data Input:
- **5 sensor features** from the dataset (temperature, pressure, torque, etc.).
- **1 target label** indicating machine **failure type**.
- Training Process:
- Dataset uploaded to IBM Cloud Lite AutoAI.
- AutoAI generated **9 pipelines** and performed **hyperparameter tuning.**
- Selected model achieved **Holdout Accuracy: 99.7% | CV Accuracy: 99.5%.**
- Prediction Process:
- Deployed model **as a cloud endpoint** for **real-time predictive maintenance**.
- Integrates with **IoT dashboards** for live alerts.

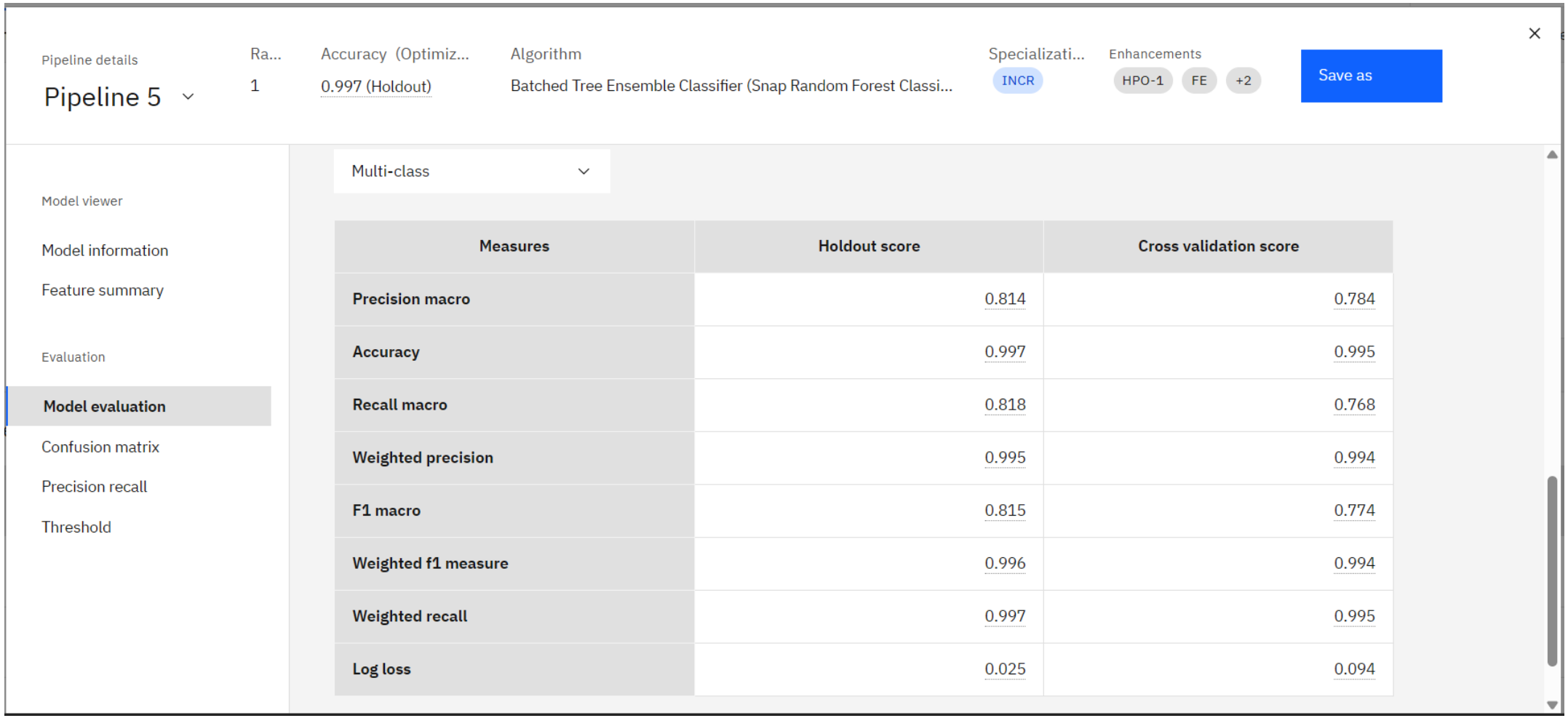
RESULT



	Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 5	Batched Tree Ensemble Classifier (Snap Random Forest Classifier)	INCR	0.995	HPO-1 FE HPO-2 BATCH	00:00:57
	2	Pipeline 4	Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:00:51
	3	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:39
	4	Pipeline 9	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:06

IBM AutoAI Pipeline Leaderboard – Model Selection and Accuracy Comparison

RESULT



Measures	Holdout score	Cross validation score
Precision macro	0.814	0.784
Accuracy	0.997	0.995
Recall macro	0.818	0.768
Weighted precision	0.995	0.994
F1 macro	0.815	0.774
Weighted f1 measure	0.996	0.994
Weighted recall	0.997	0.995
Log loss	0.025	0.094

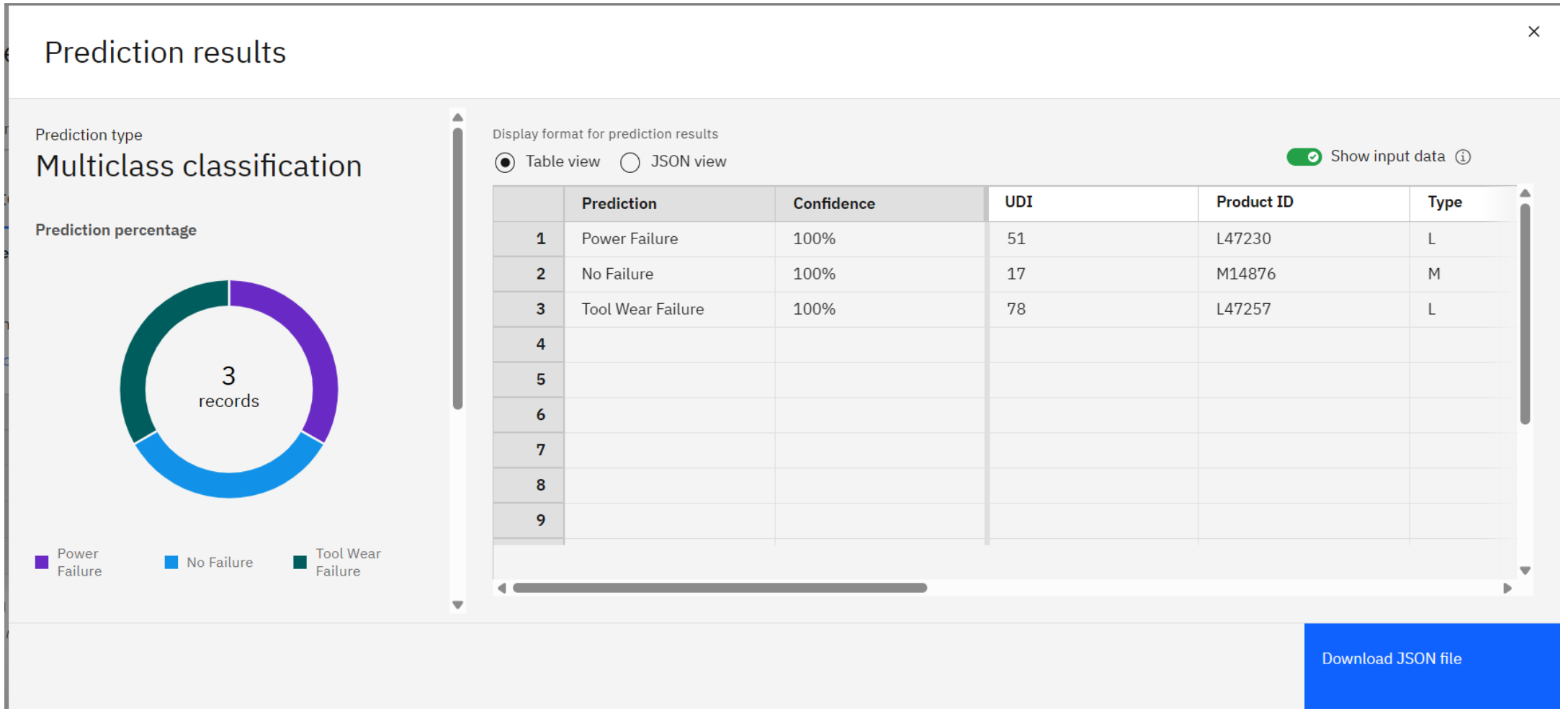
Comprehensive Model Performance and Accuracy Metrics

RESULT

Observed	Predicted						
	Heat Dissipation Failure	No Failure	Overstrain Failure	Power Failure	Random Failures	Tool Wear Failure	Percent correct
Heat Dissipation Failure	10	0	1	0	0	0	90.9%
No Failure	0	965	0	0	0	0	100.0%
Overstrain Failure	0	0	8	0	0	0	100.0%
Power Failure	0	0	0	10	0	0	100.0%
Random Failures	0	2	0	0	0	0	0.0%
Tool Wear Failure	0	0	0	0	0	4	100.0%
Percent correct	100.0%	99.8%	88.9%	100.0%	0.0%	100.0%	99.7%

Confusion Matrix

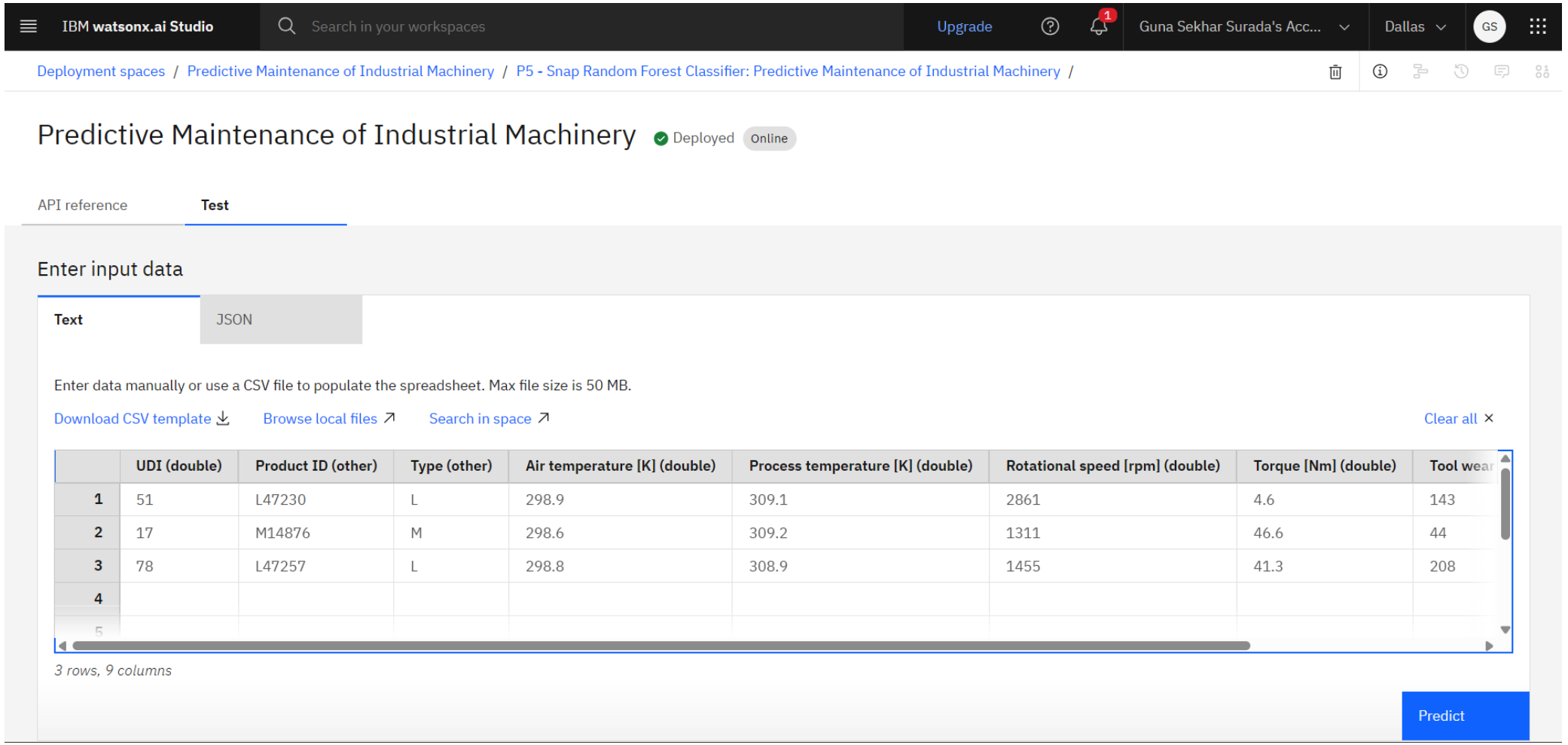
RESULT



	Prediction	Confidence	UDI	Product ID	Type
1	Power Failure	100%	51	L47230	L
2	No Failure	100%	17	M14876	M
3	Tool Wear Failure	100%	78	L47257	L
4					
5					
6					
7					
8					
9					

Multiclass Prediction Results with Confidence Scores

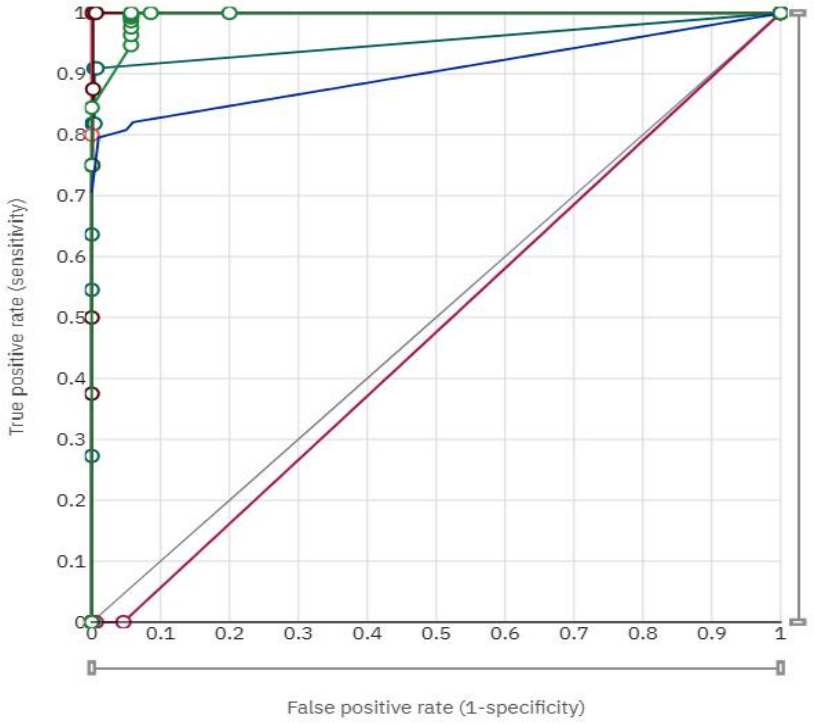
RESULT



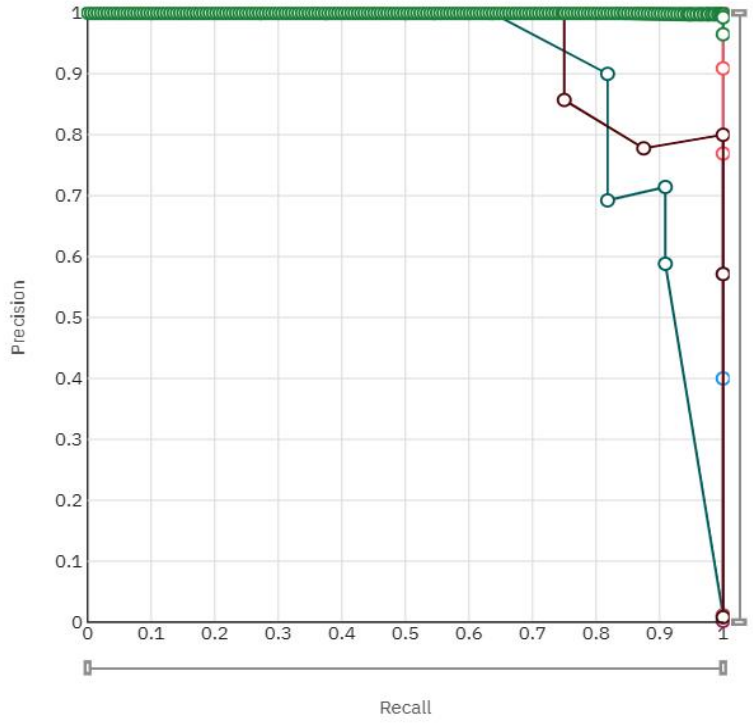
Model Deployment and Testing Data for Prediction

edunet foundation

RESULT

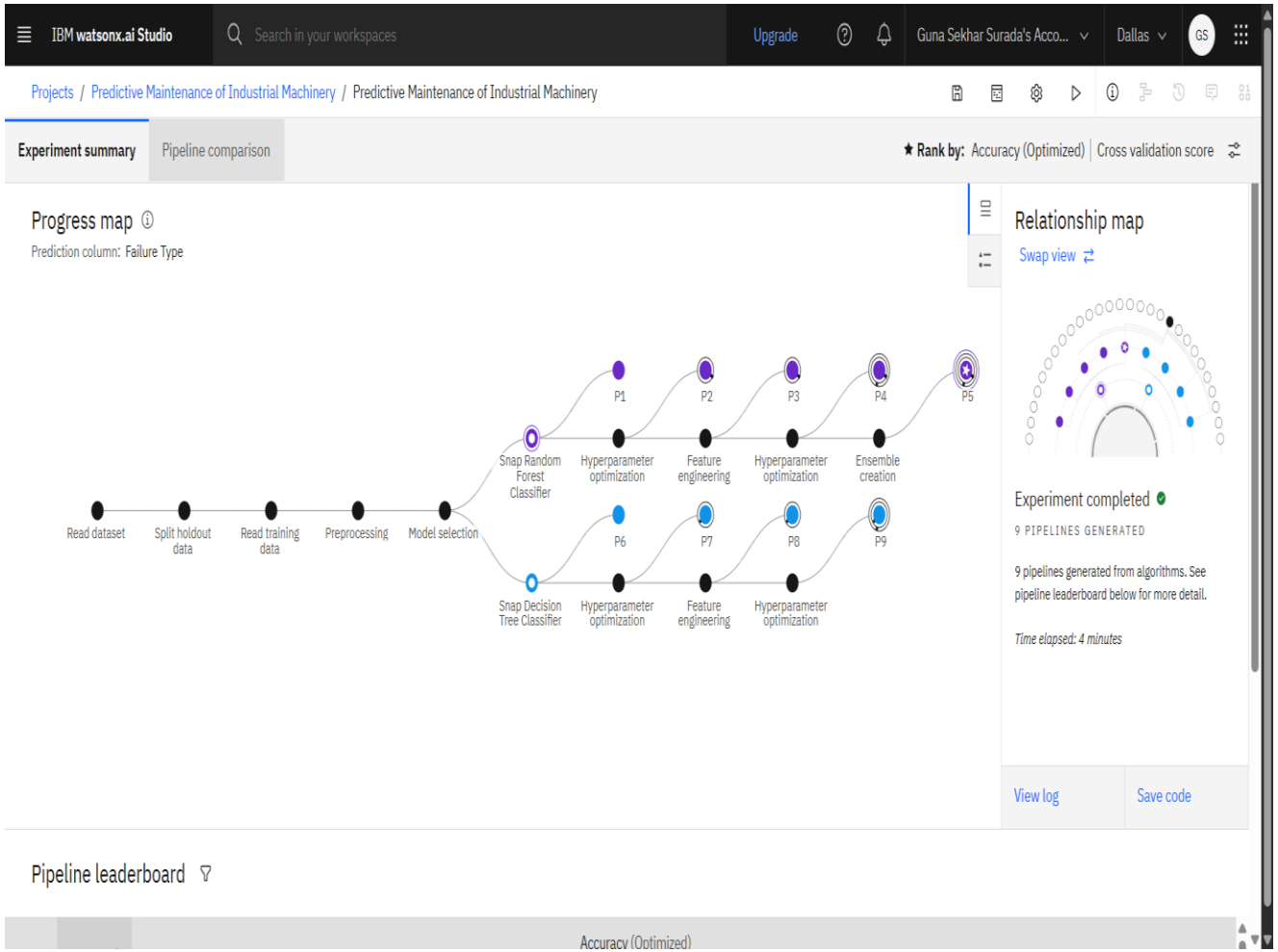


ROC Curve

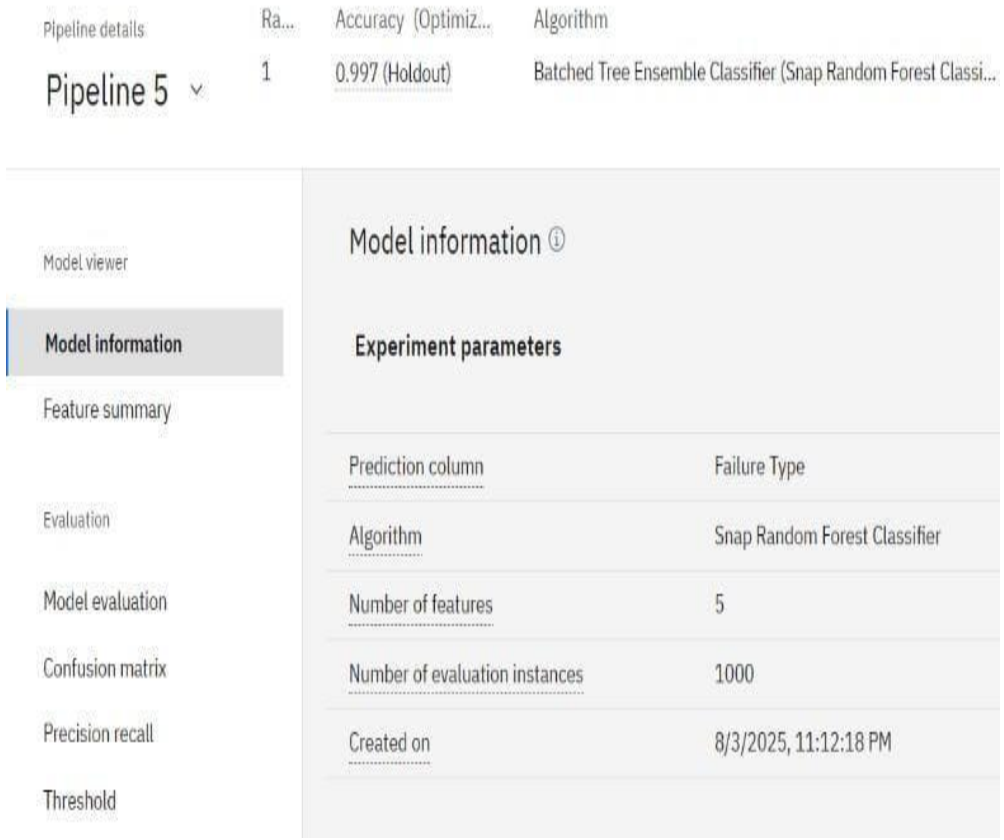


Precision-Recall Curve

RESULT



Progress Map



Model Information

CONCLUSION

- This project successfully **developed and deployed a cloud-based predictive maintenance system** using **IBM Cloud Lite and Watson Studio AutoAI**. By **analyzing real-time sensor data** to identify patterns that precede machine failures, the model achieved **99.7% prediction accuracy** with **high precision and recall**.
- **Key outcomes:**
- **Early failure prediction** minimized unplanned downtime.
- **Optimized maintenance scheduling** reduced operational costs.
- **Reliable classification of multiple failure types** (Tool Wear, Power Failure, Heat Dissipation, Overstrain).
- This demonstrates the **effectiveness of AI-driven predictive maintenance** in improving **industrial reliability and efficiency**.

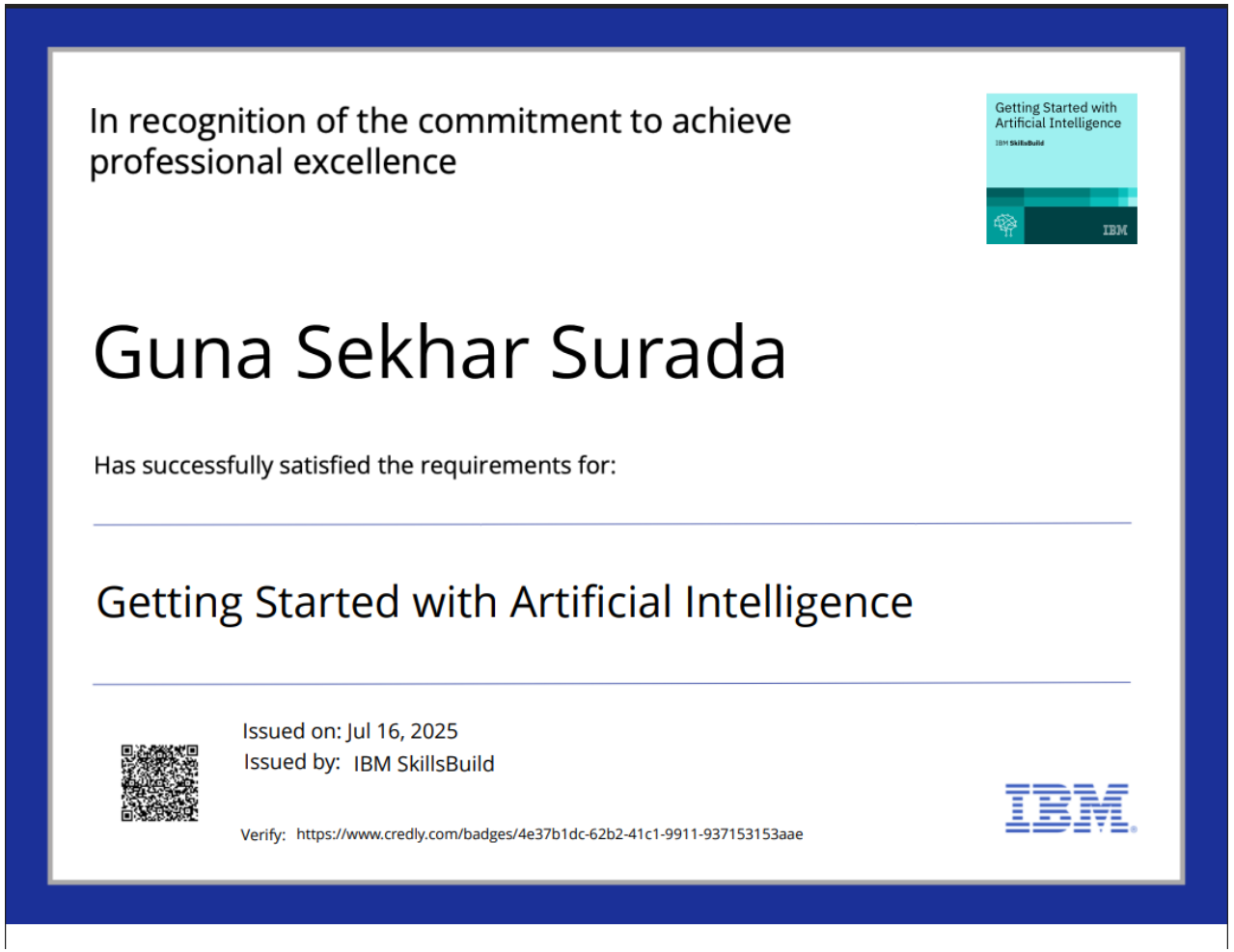
FUTURE SCOPE

- **Integration with live IoT sensor streams** to enable **real-time monitoring and automated alerts.**
- **Edge Computing Deployment** for **instant, on-site predictions** without cloud latency.
- **Expansion to diverse industrial machine types** and **larger datasets** for higher generalization.
- **Hybrid Machine Learning + Deep Learning models** to detect **rare and complex failure modes.**
- **Predictive maintenance dashboards** for **visual analytics and maintenance planning.**

REFERENCES

- **Kaggle dataset link** – https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification
- **Github Link** – https://github.com/gunasekhar1706/Final-Project-Submission.git
- IBM Watson Studio AutoAI Documentation
- IBM Cloud Lite Deployment Guide
- Research papers on **Predictive Maintenance and Failure Classification**

IBM CERTIFICATIONS



In recognition of the commitment to achieve professional excellence

Getting Started with Artificial Intelligence
IBM SkillsBuild

IBM

Guna Sekhar Surada

Has successfully satisfied the requirements for:

Getting Started with Artificial Intelligence

Issued on: Jul 16, 2025
Issued by: IBM SkillsBuild

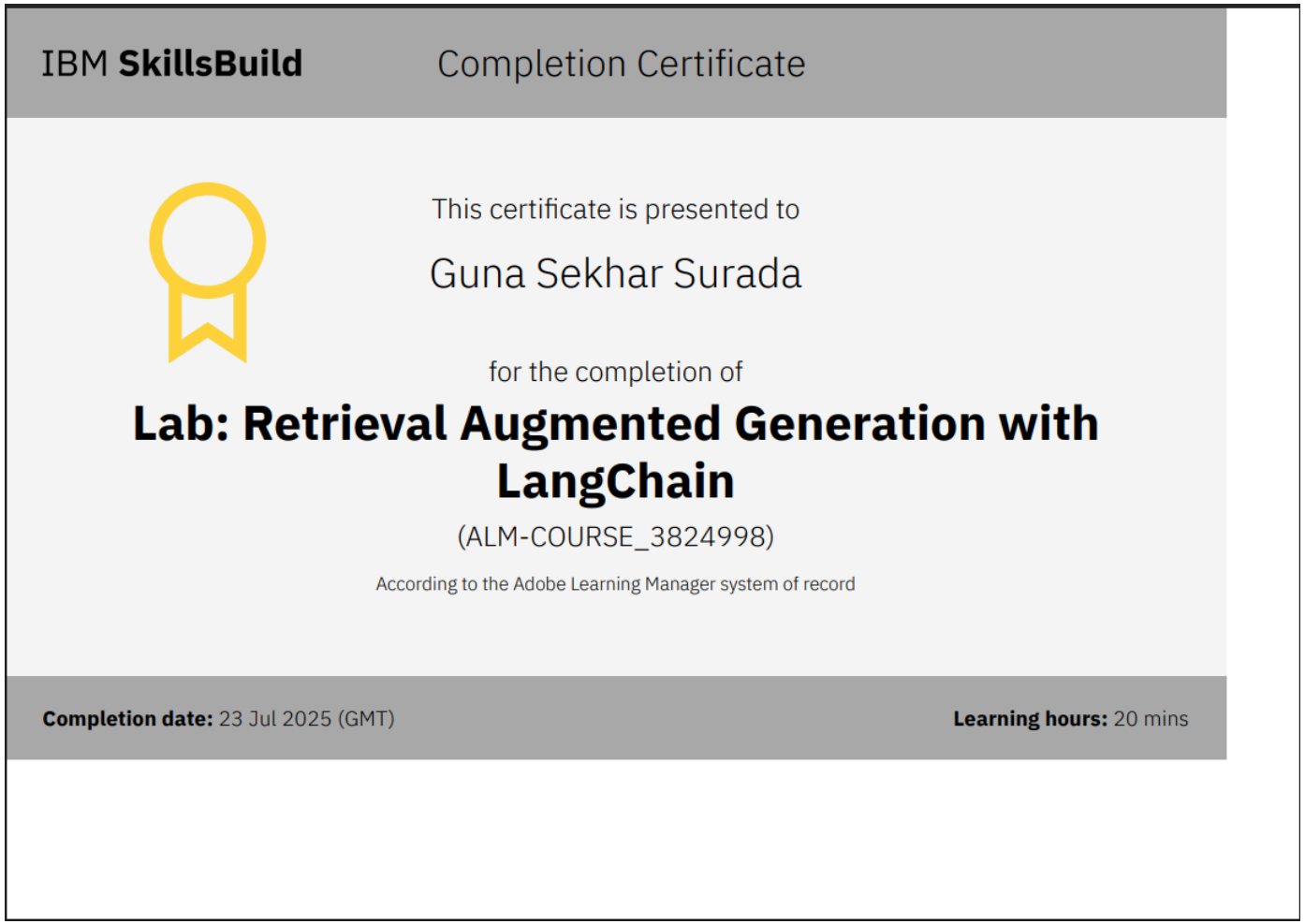
Verify: https://www.credly.com/badges/4e37b1dc-62b2-41c1-9911-937153153aae

IBM

IBM CERTIFICATIONS

edunet foundation

IBM CERTIFICATIONS



IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Guna Sekhar Surada

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

edunet foundation