CAPSTONE PROJECT

PS-39: PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY USING MACHINE LEARNING

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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

This project develops a machine learning model to classify the "Failure Type" of industrial machines using sensor data. It aims to automate fault detection and enable faster, proactive maintenance.

- Key Components
- Data Collection

1. Dataset: Kaggle – “Machine Predictive Maintenance Classification”
2. Includes sensor and machine condition metrics.

- Preprocessing

1. Data cleaning, normalization, and splitting into training and holdout sets (as per Watsonx.ai pipeline).

- Model Training

1. IBM Watsonx.ai Studio used to build 8 pipelines with:
2. Random Forest and Decision Tree classifiers
3. Hyperparameter tuning and feature engineering

- Evaluation

1. Metrics: Accuracy, Precision, Recall, F1-score, and cross-validation
2. Best model selected based on optimized accuracy ranking

SYSTEM APPROACH

The system development approach outlines the tools and technologies used to design, build, and deploy the failure prediction model. The solution was developed and implemented using IBM Cloud services to ensure scalability, reliability, and integration.

- System Requirements and Tools:

  IBM Cloud (Mandatory)

  The core cloud platform used for hosting and managing all services.

  IBM Watson Studio

  Utilized for building, training, and optimizing the machine learning model using AutoAI.

  IBM Cloud Object Storage

  Used for secure storage and seamless access to the dataset during preprocessing and model training.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection**

  Random Forest Classifier and Decision Tree Classifier were selected for their effectiveness in multi-class classification tasks and handling structured tabular data.

- **Data Input**

  UDI, Product ID, Type, Air temperature [K], Process temperature [K], Rotational speed [rpm], Torque [Nm], Tool wear [min], Target (Failure Type)

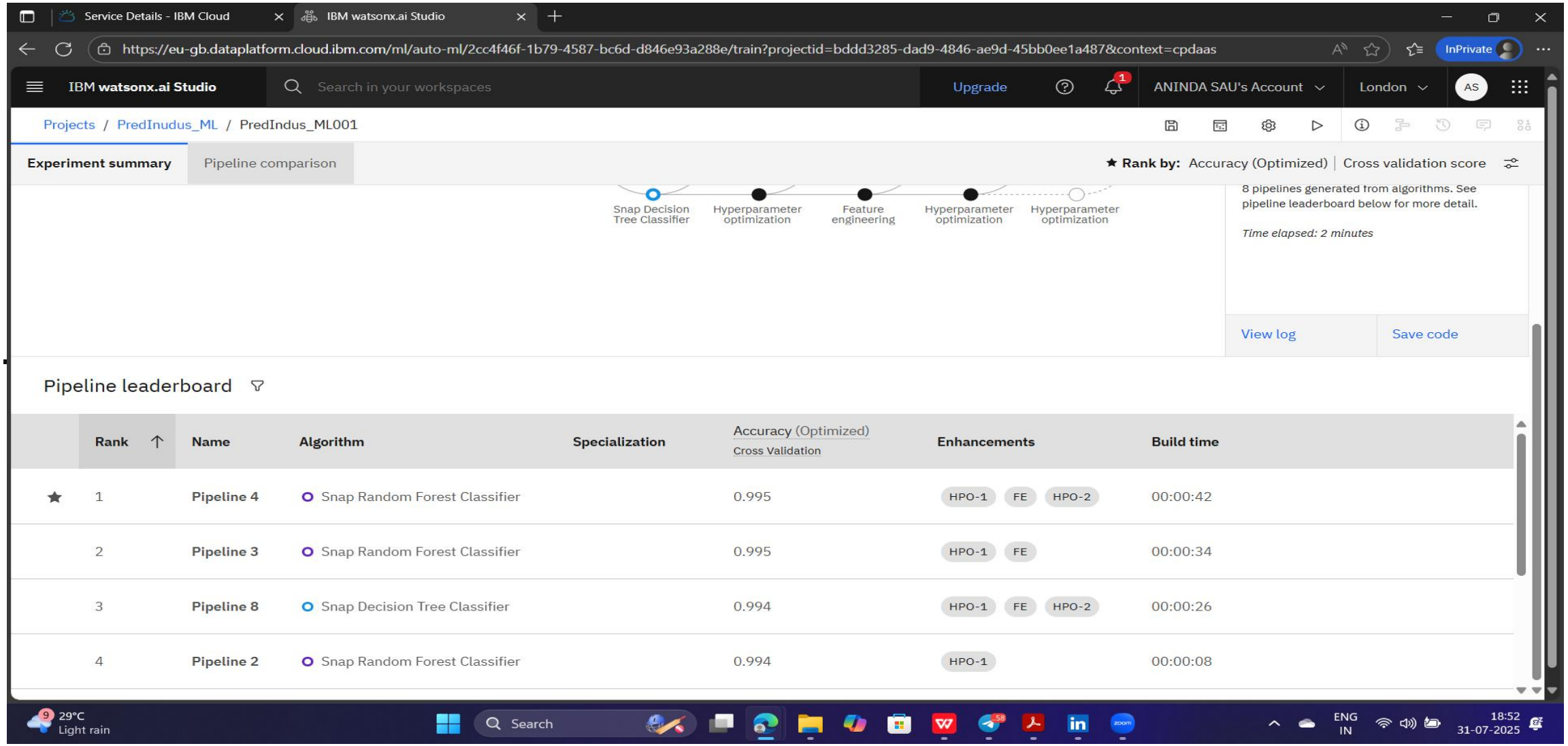
- **Training Process**

  The dataset was split into 90% for training and 10% for testing. Training and optimization were done using IBM Watson Studio's AutoAI feature.

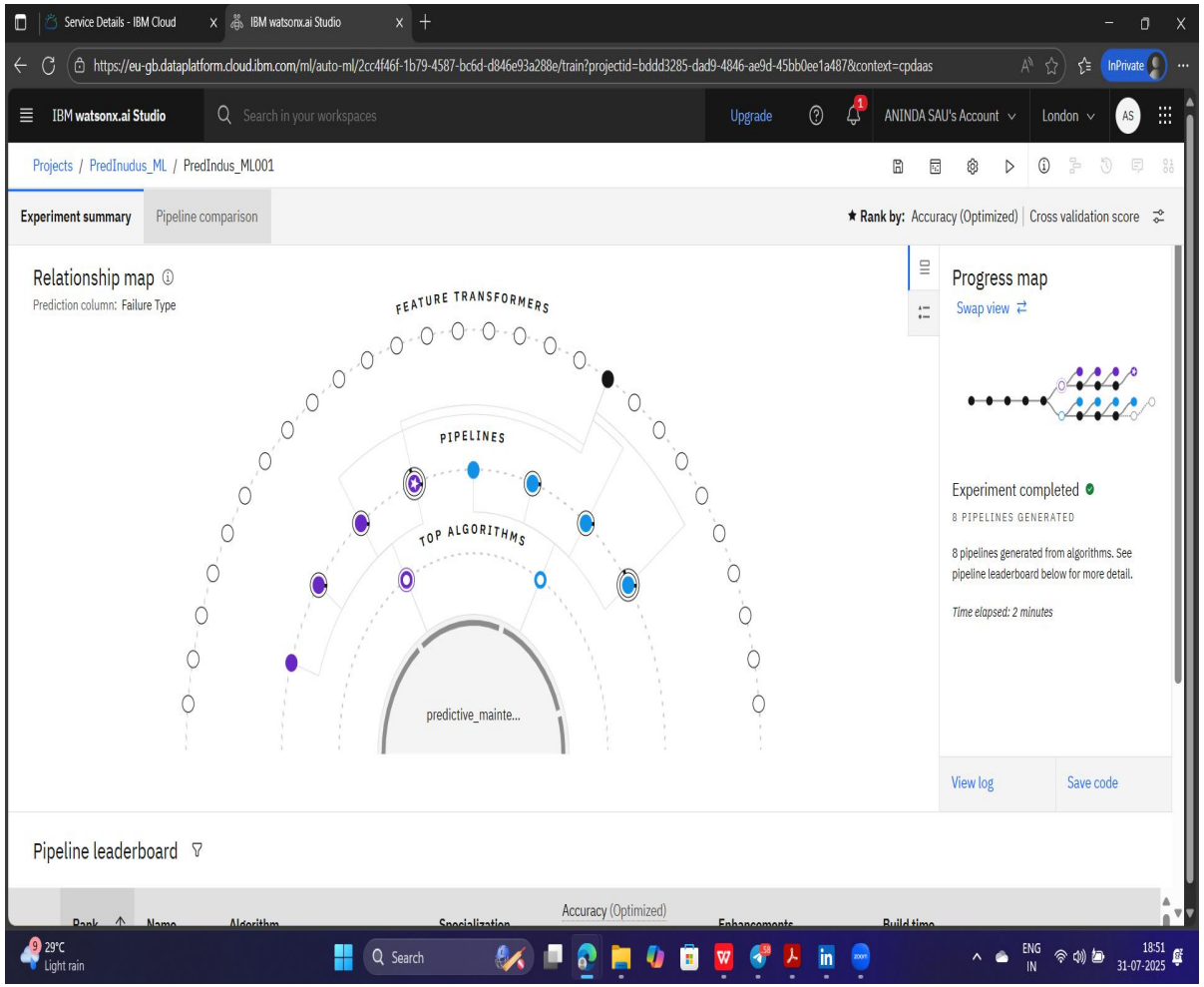
- **Prediction Process**

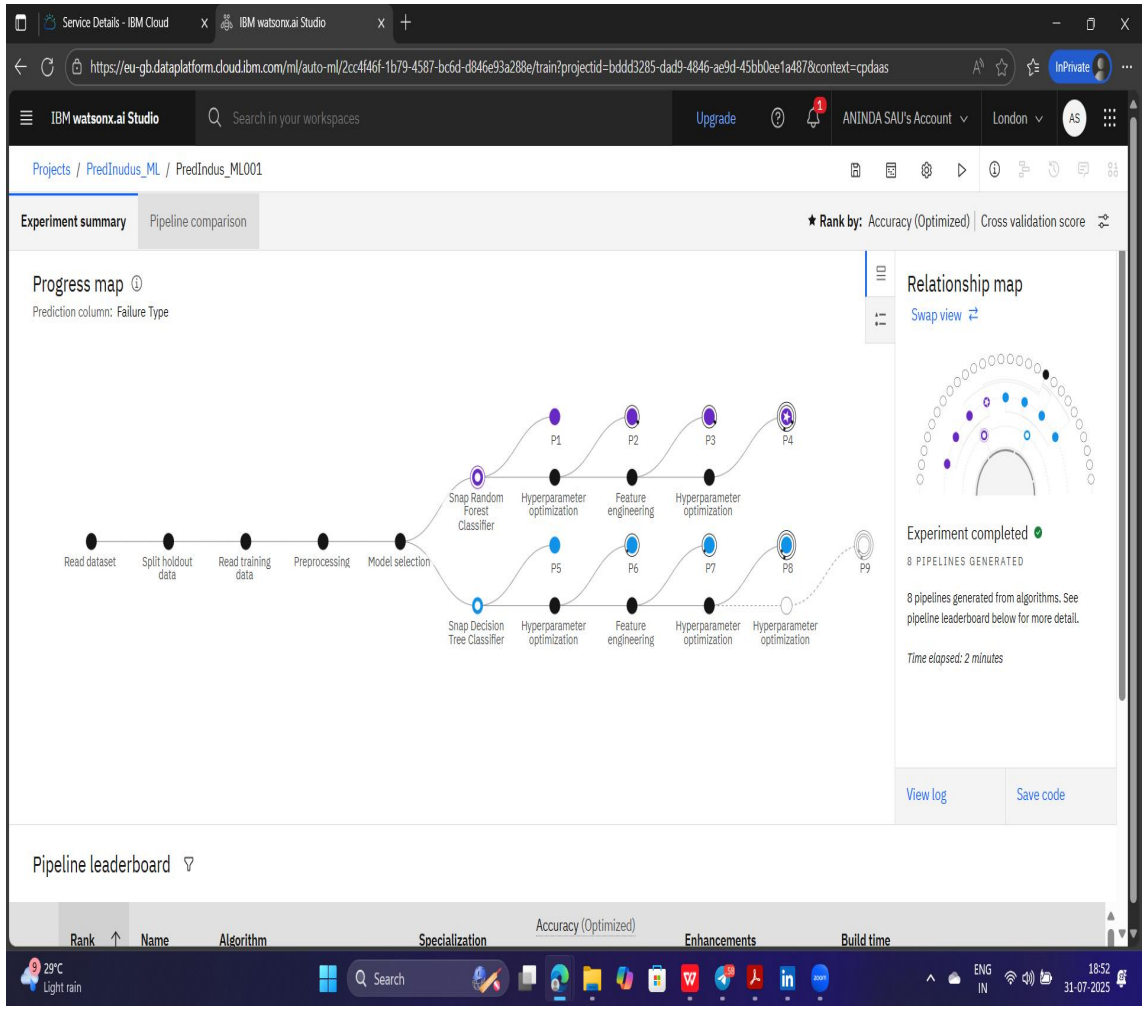
  The trained model predicts various failure types, including: No Failure, Power Failure, Tool Wear Failure, Overstrain Failure, Heat Dissipation Failure, and Random Failures.

RESULT



RESULT





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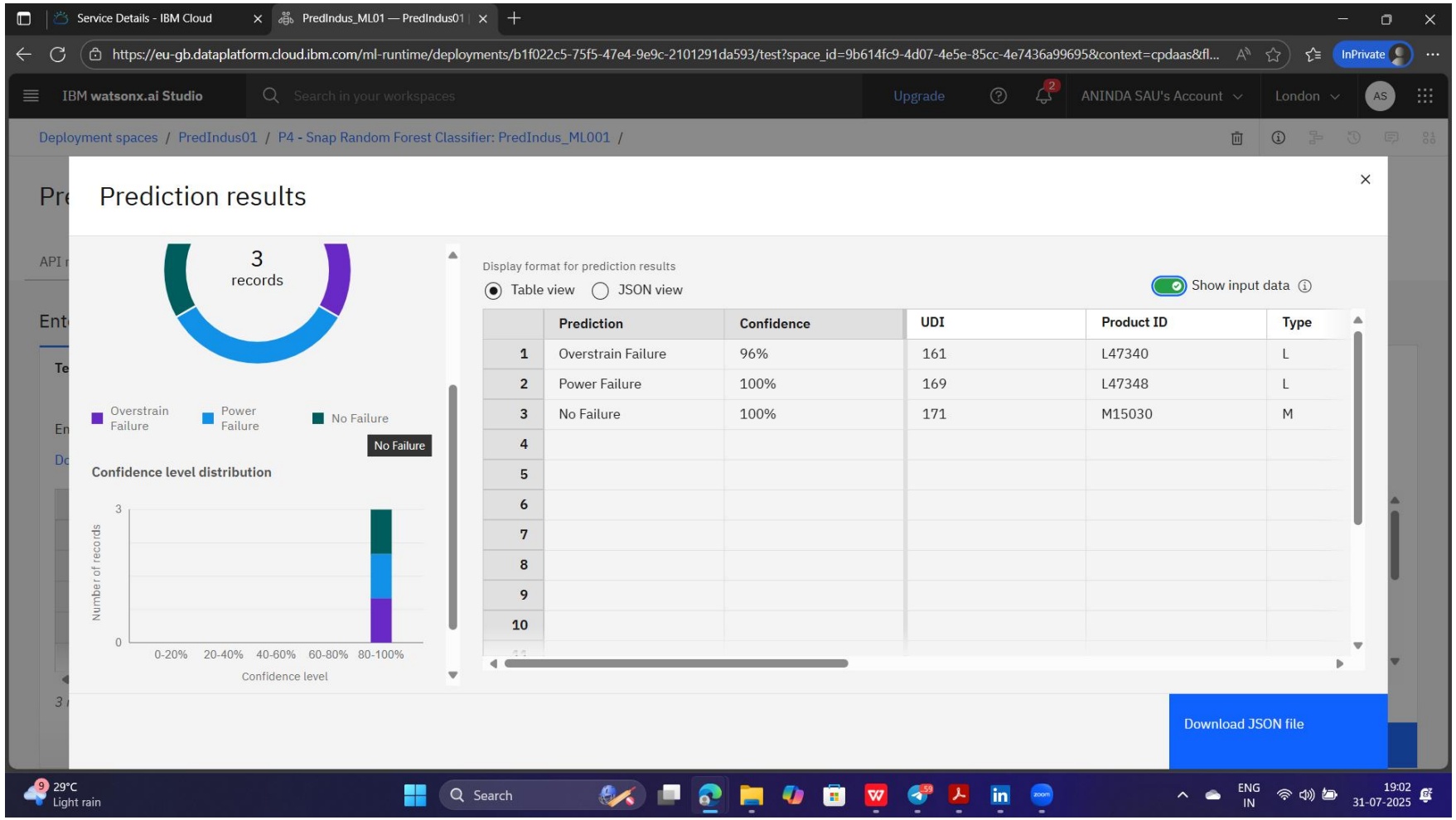
RESULT



	Prediction	Confidence	UDI	Product ID	Type
1	Overstrain Failure	96%	161	L47340	L
2	Power Failure	100%	169	L47348	L
3	No Failure	100%	171	M15030	M
4					
5					
6					
7					
8					
9					
10					

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CONCLUSION

- Deploying machine learning models using IBM Cloud AutoAI is both efficient and user-friendly. With its automated features, I was able to build a classification model that achieved up to 99% accuracy, demonstrating its effectiveness in industrial failure prediction tasks. This platform simplifies the end-to-end process—from data preprocessing to model deployment—making it ideal for handling large datasets in real-world applications.
- By leveraging IBM Cloud, industries can significantly improve time management and gain faster insights, enabling proactive decision-making. However, as the system relies on cloud infrastructure, network stability is essential for seamless performance. IBM Cloud also offers a wide range of additional services that further enhance the development experience.

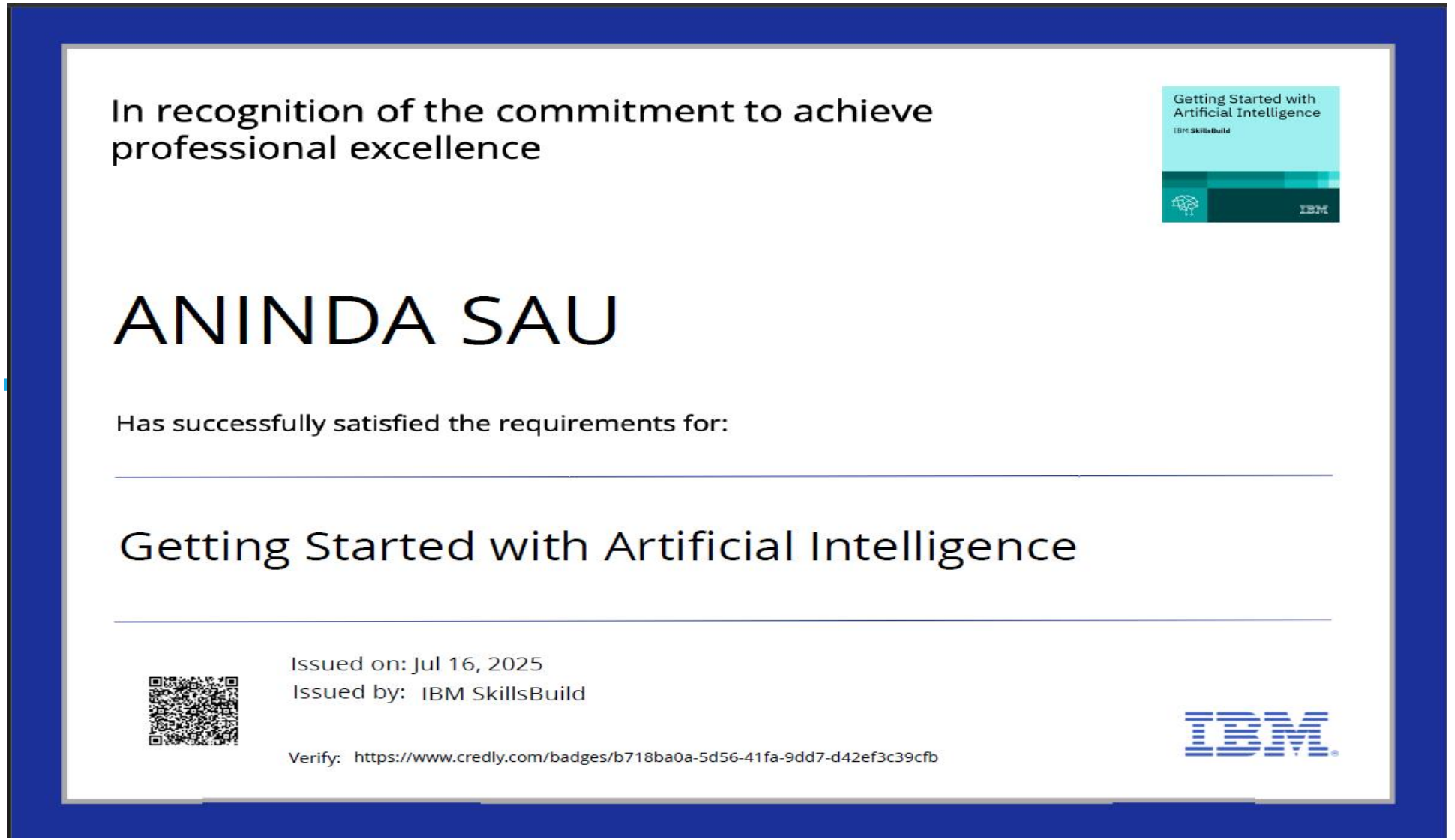
FUTURE SCOPE

- While IBM Cloud AutoAI has enabled effective industrial failure prediction, future improvements could include integrating more diverse real-time data and leveraging edge computing to reduce cloud dependency and latency. Expanding the system across multiple locations and using IBM Cloud's advanced services will enhance scalability, security, and insight generation. These enhancements will help industries make faster, more reliable decisions and improve overall operational efficiency.

REFERENCES

- **IBM CLOUD** - https://www.ibm.com/cloud
- **WATSONX.AI STUDIO** - https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChsSEwjMt57i0ueOAxUabQ8CHVOxEikYACICCAEQABoCdGI&ae=2&co=1&ase=2&gclid=CjwKCAjwqKzEBhANEiwAeQaPVTE7VkaXrrcU3q18Inkw__E-xTFrZi670iANnZdpckWI4FCMFd-k5RoCvqEQAvD_BwE&ohost=www.google.com&cid=CAESV-D2IAZii6NOo5v6Z_0MHcUFPa144nG-qcfYBZlgbKpFux9pJWAWIRJfr3YtOCNJrTtyqQh-y4CJoaKNwI4cEivnSs60zXRDmCRIEgnchP4HvN6voasdpg&category=acrcp_v1_79&sig=A0D64_3j7JTBRyxALuRsJv3uyQ0fOmqqUA&q&nis=4&adurl&ved=2ahUKEwjP0pji0ueOAxXGnq8BHcUHHqcQ0Qx6BAgJEAE
- **KAGGLE DATASET** - https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

IBM CERTIFICATIONS



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