CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

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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

- 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

- **Our solution is a machine learning pipeline designed to move from raw data to actionable predictions.**
- **Data Collection & Understanding:**
  - Utilize the Kaggle "Predictive Maintenance Classification" dataset.
  - This dataset includes sensor readings like air temperature, process temperature, rotational speed, torque, and tool wear.
- **Data Preprocessing:**
  - Clean the data by handling missing values.
  - Perform feature engineering to create new, informative features.
  - Encode categorical variables (like 'Type') into numerical format.
  - Scale numerical features to ensure the model treats them equally.
- **Model Training & Evaluation:**
  - Split the data into training and testing sets (e.g., 80/20 split).
  - Train a classification model on the training data to learn the relationship between sensor readings and failure types.
  - Evaluate the model's performance on the unseen test data using metrics like Accuracy,
  - Precision, Recall, and the Confusion Matrix.

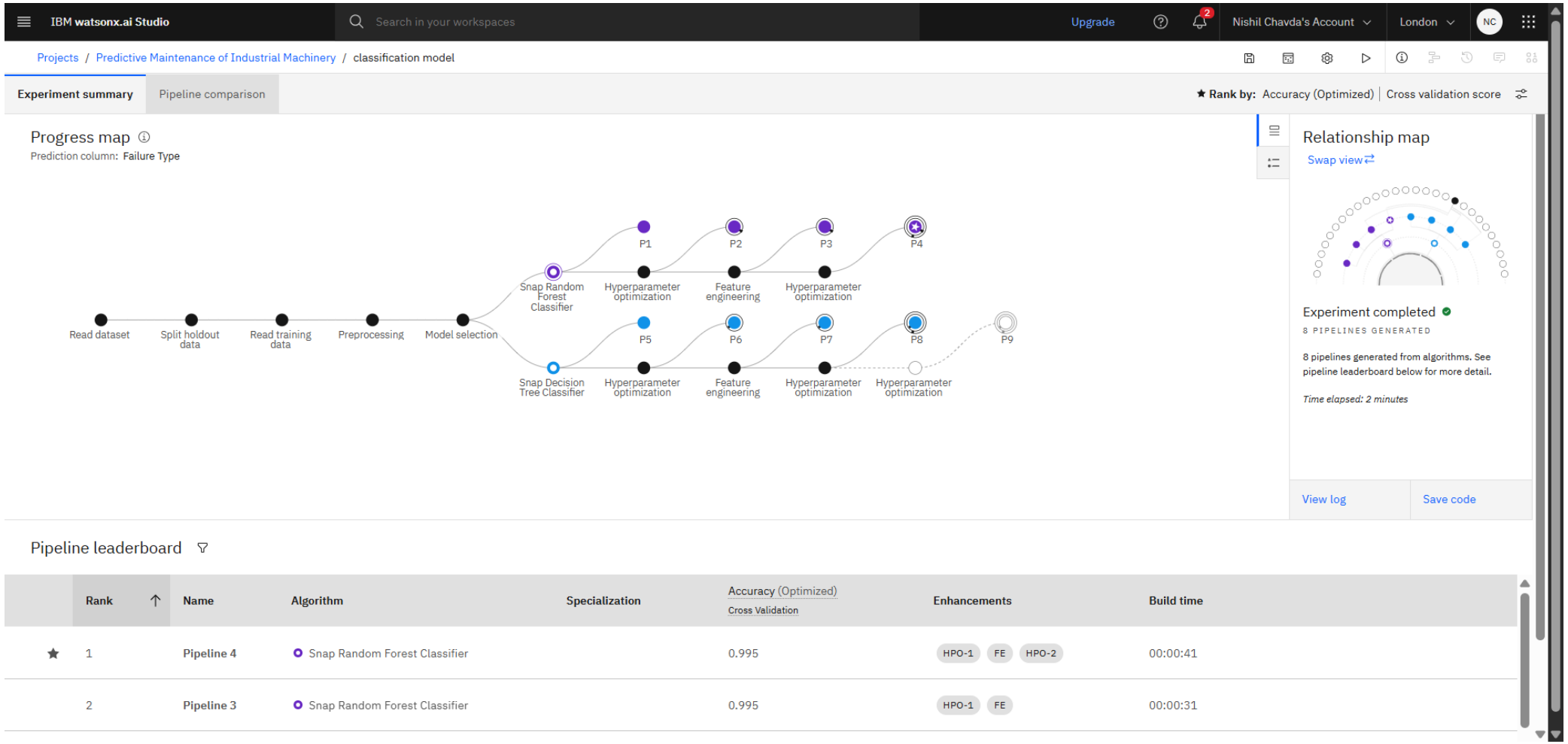
SYSTEM APPROACH

- **This section outlines the methodology and the specific technologies used to develop and implement the power system fault detection and classification model.**
- **System requirements :**
  - IBM Cloud(mandatory)
  - IBM Watson studio for model development and deployment
  - IBM cloud object storage for dataset handling

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Random Forest Classifier: This powerful ensemble algorithm was chosen for its high accuracy and its ability to handle complex interactions between different sensor readings without extensive feature engineering.
- **Data Input:**
  - Sensor measurements from the dataset, including Air Temperature, Process Temperature, Rotational Speed, Torque, and Tool Wear.
- **Training Process:**
  - Supervised Learning using the pre-labeled dataset where each instance is tagged with a specific failure type (e.g., "Tool Wear Failure," "Heat Dissipation Failure," or "No Failure").
- **Prediction Process:**
  - The final, trained model is deployed on IBM Watson Studio, which provides a secure API endpoint. This allows for real-time predictions by sending new sensor data to the model.

RESULT



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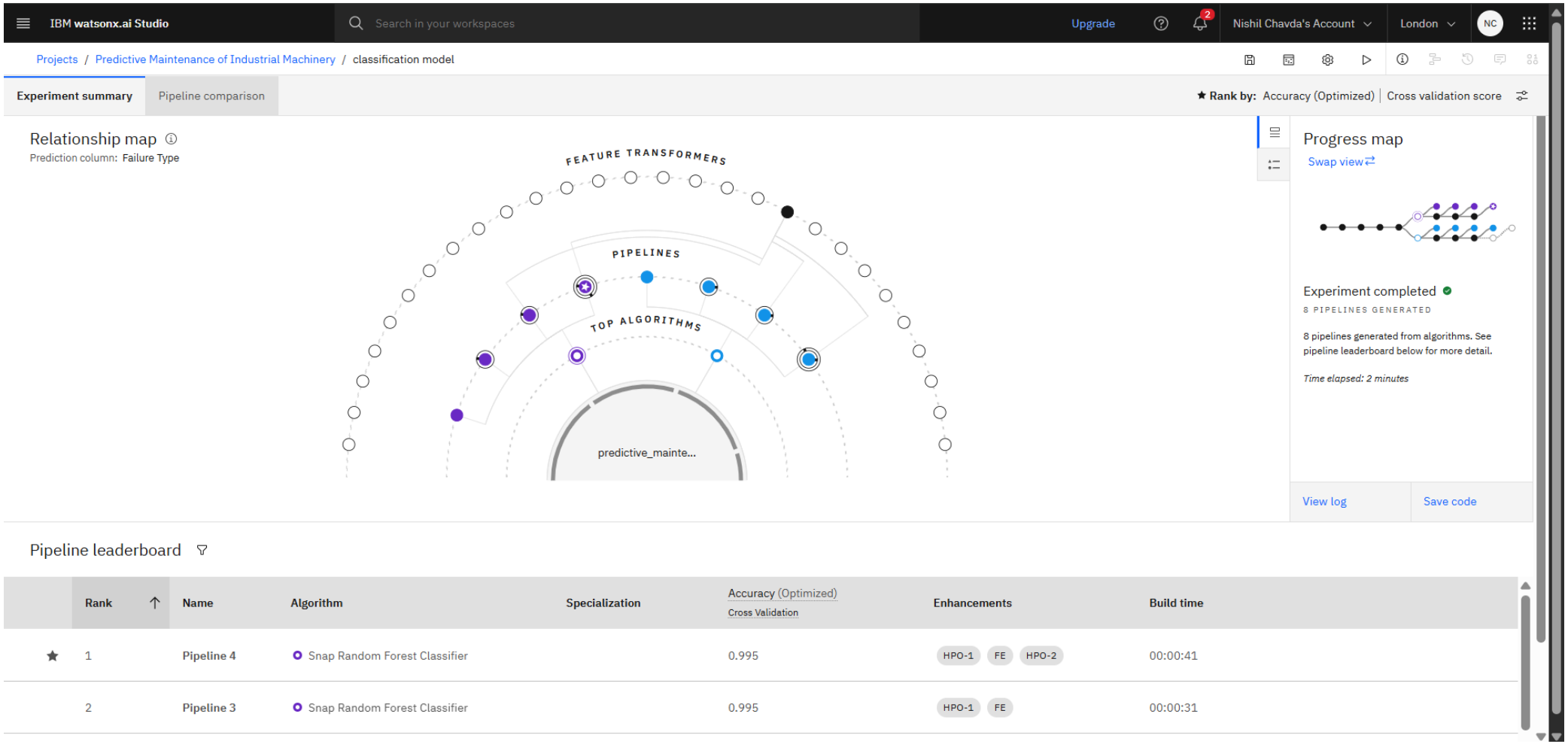
RESULT



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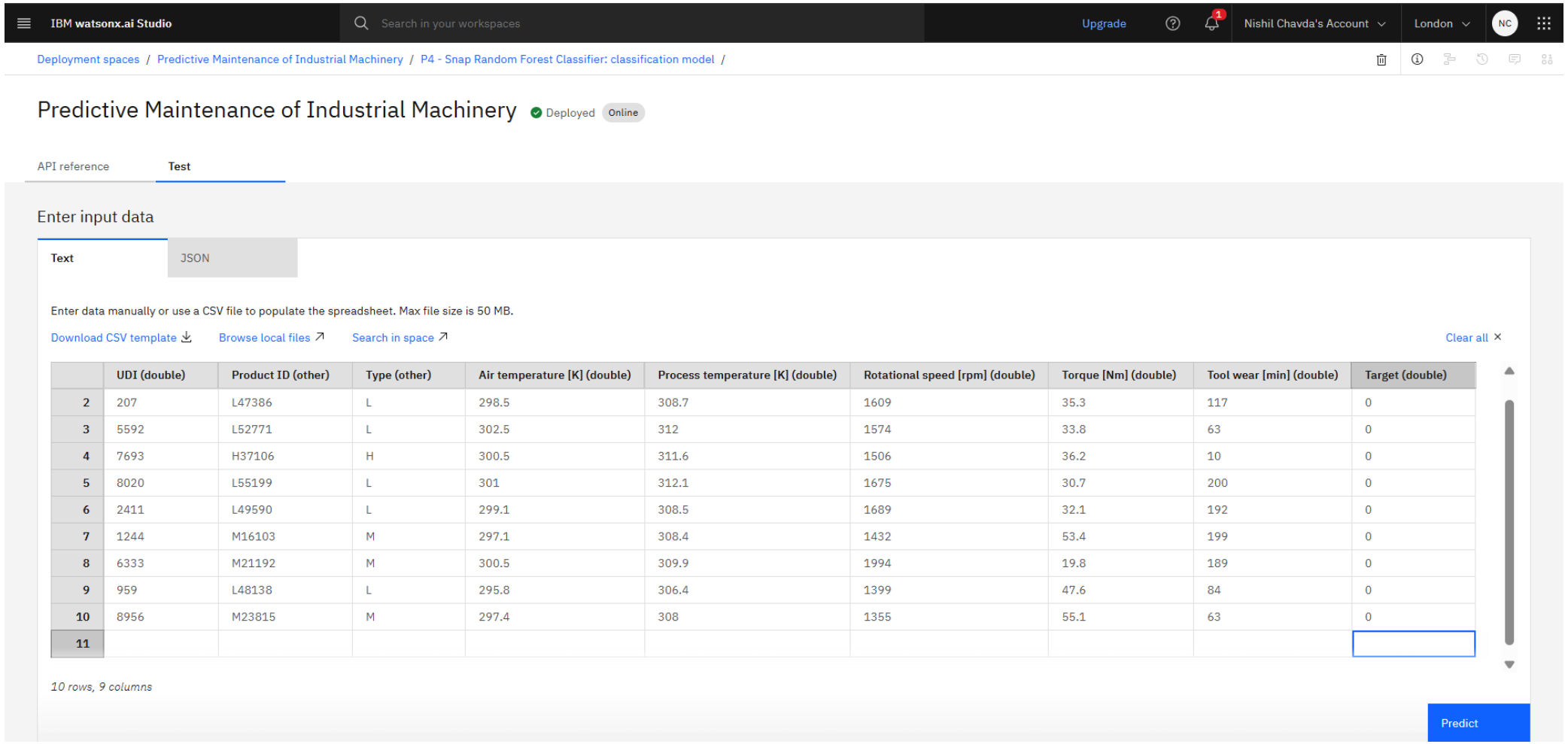
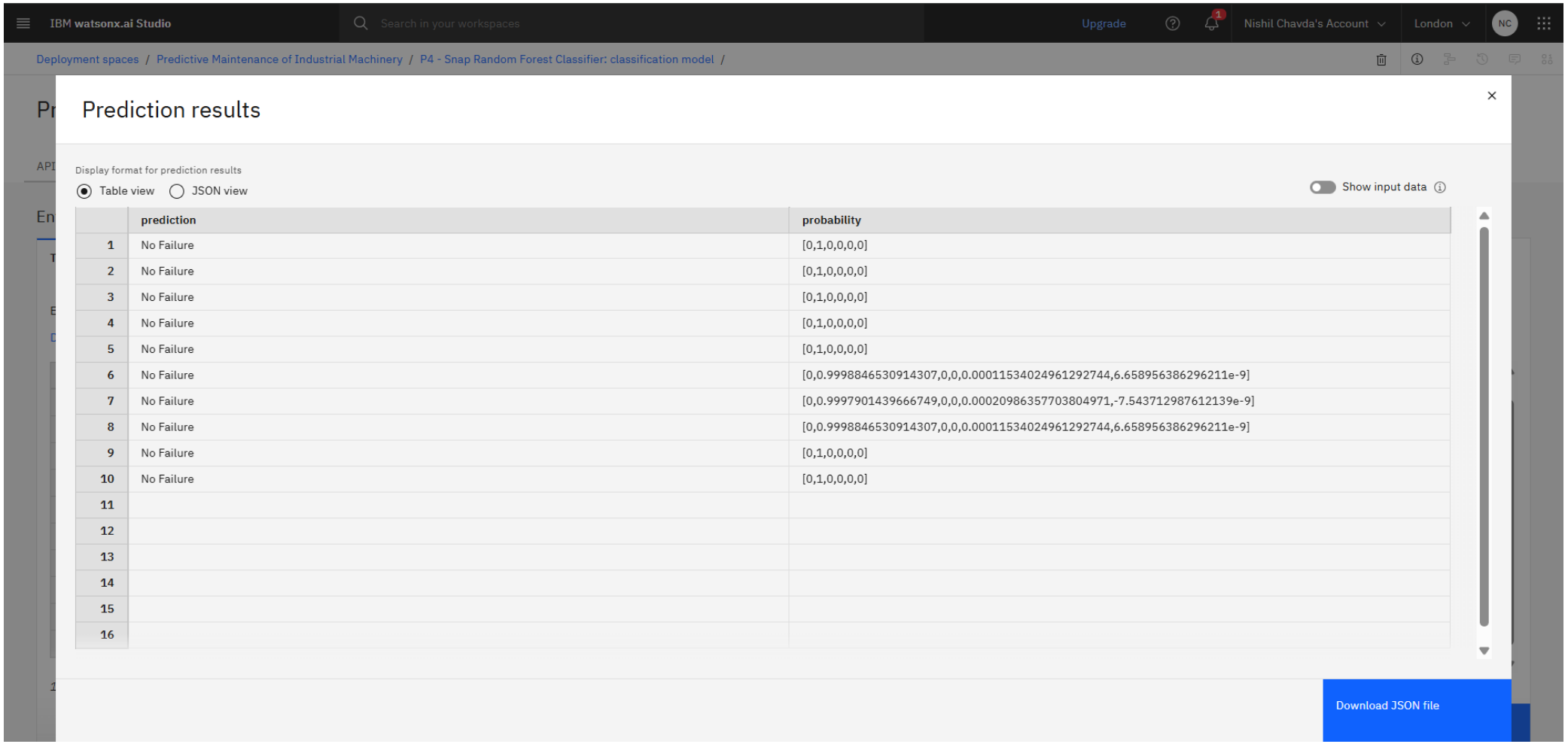
RESULT



	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)
2	207	L47386	L	298.5	308.7	1609	35.3	117	0
3	5592	L52771	L	302.5	312	1574	33.8	63	0
4	7693	H37106	H	300.5	311.6	1506	36.2	10	0
5	8020	L55199	L	301	312.1	1675	30.7	200	0
6	2411	L49590	L	299.1	308.5	1689	32.1	192	0
7	1244	M16103	M	297.1	308.4	1432	53.4	199	0
8	6333	M21192	M	300.5	309.9	1994	19.8	189	0
9	959	L48138	L	295.8	306.4	1399	47.6	84	0
10	8956	M23815	M	297.4	308	1355	55.1	63	0
11									

RESULT



	prediction	probability
1	No Failure	[0,1,0,0,0,0]
2	No Failure	[0,1,0,0,0,0]
3	No Failure	[0,1,0,0,0,0]
4	No Failure	[0,1,0,0,0,0]
5	No Failure	[0,1,0,0,0,0]
6	No Failure	[0,0.9998846530914307,0,0,0.00011534024961292744,6.658956386296211e-9]
7	No Failure	[0,0.9997901439666749,0,0,0.00020986357703804971,-7.543712987612139e-9]
8	No Failure	[0,0.9998846530914307,0,0,0.00011534024961292744,6.658956386296211e-9]
9	No Failure	[0,1,0,0,0,0]
10	No Failure	[0,1,0,0,0,0]
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CONCLUSION

- Successfully developed and deployed a machine learning model capable of predicting industrial machinery failures with high accuracy.
- The system can classify the specific type of failure, enabling targeted maintenance actions.
- The use of IBM Cloud provides a scalable and robust platform for real-world deployment.
- This solution directly addresses the business need to reduce unplanned downtime, lower maintenance costs, and improve operational efficiency.

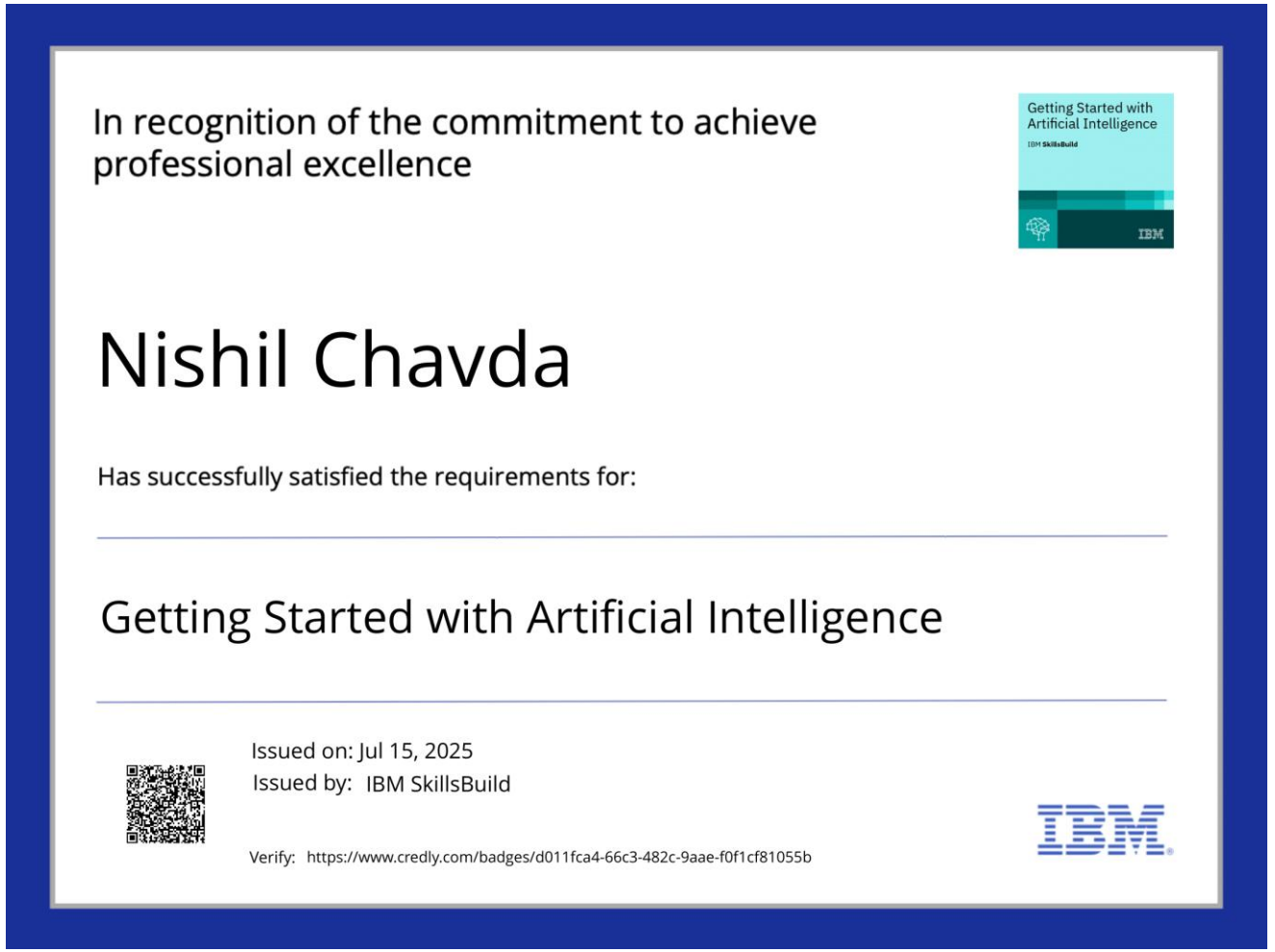
FUTURE SCOPE

- **Real-time Dashboard:** Develop an interactive dashboard to visualize real-time predictions and machine health scores for plant managers.
- **Advanced Models:** Explore deep learning models like Long Short-Term Memory (LSTM) networks to better capture time-series dependencies in sensor data.
- **Expanded Data Integration:** Incorporate additional data sources, such as maintenance logs, environmental data, or machine specifications, to enhance model accuracy.
- **Automated Retraining:** Implement a pipeline to automatically retrain the model with new data to prevent model drift and maintain performance over time.

REFERENCES

- **Dataset**:
  - Shivam, B. (2020). AI4I 2020 Predictive Maintenance Dataset. Kaggle. https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classificationTechnology

IBM CERTIFICATIONS



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IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution
IBM SkillsBuild

Nishil Chavda

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

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

Verify: https://www.credly.com/badges/37a95881-f5bb-4cab-8d14-b0e8910a9736

IBM

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IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Nishil Chavda

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

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