CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY THE CHALLENGE

Presented By:

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OUTLINE

- **Problem Statement**
- **Proposed System/Solution**
- **System Development Approach** (Machine Learning)
- **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.
- **Objective:** Develop a predictive maintenance model to anticipate machine failures.
- **Challenge**: Use sensor data to identify patterns that precede failures.
- Target : Failure or Not
- Failure Type : Type of Failure
- **Impact**: Reduce downtime and operational costs through proactive maintenance.

PROPOSED SOLUTION

- **1. Data Collection:-** Gather synthetic sensor data from industrial machines, including: Air temperature, process temperature, rotational speed, torque, tool wea , Product quality indicators (L/M/H), Machine failure labels and failure types, Integrate real-time operational data streams for future scalability.
- **2. Data Preprocessing:-** Clean and preprocess the dataset:- Handle missing values, outliers, and normalize sensor readings. Ensure no data leakage by excluding target labels from feature se, Perform feature engineering.
- **3. Machine Learning Algorithm:-**
- **-** Binary classification: Failure vs. No Failure
- - Multi-class classification: Type of failure (tool wear, heat dissipation, etc.)
- - Algorithms considered:
- - Random Forest, Logistic Regression
- - Neural Networks for deeper pattern recognition
- - Incorporate domain-specific features like product quality and operational stress indicators
- **4. Deployment (IBM Cloud Lite Services):-** Use IBM Watson Studio for model development and training. Store data using IBM Cloud Object Storage. Deploy model as an API or web app using IBM Code Engine. Ensure scalability, low latency, and secure access for industrial stakeholders
- **5. Evaluation:-** Accuracy, Precision, Recall, F1 Score. Confusion matrix for classification clarity. Perform cross-validation and hyperparameter tuning . Continuously monitor prediction accuracy and retrain with updated data
- **6. Result:-** Achieve reliable prediction of machine failures and their types. Enable proactive maintenance scheduling, reducing unexpected breakdowns. Improve operational efficiency and cost savings for industrial operations. Demonstrate successful integration of ML with IBM Cloud Lite services.

SYSTEM APPROACH

The System Approach selection outlines strategy and methodology for developing and implementing the "Predictive Maintenance of Industrial Machinery The Challenge". Here is suggested structure for this section.

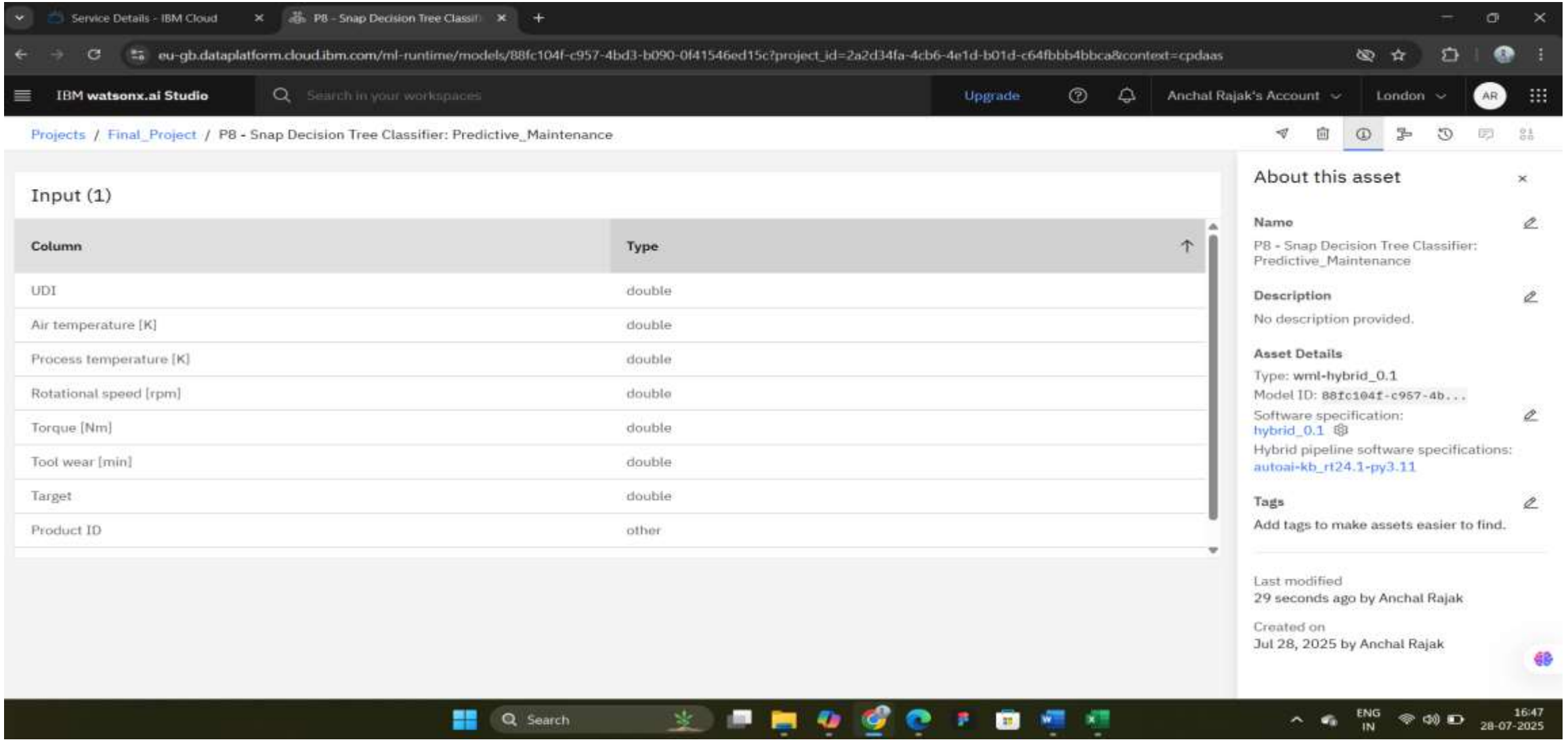
System requirements:-

- Use IBM Watson Studio for model development and training.
- Store data using IBM Cloud Object Storage.
- IBM cloud object storage for dataset handling.
- Deploy model as an API or web app using IBM Code Engine.
- Ensure scalability, low latency, and secure access for industrial stakeholders.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Random Forest Classifier, Logistic Regression.
  - tool wear, heat dissipation, power failure.
  - Failure vs. No Failure and Overstrain Failure
- **Data Input:**
  - UID: unique identifier ranging from 1 to 10000
  - Product ID: consisting of a letter L, M, or H for low (50% of all products), medium (30%), and high (20%) as product quality variants and a variant-specific serial number
  - air temperature [K]: generated using a random walk process later normalized to a standard deviation of 2 K around 300 K
  - process temperature [K]: generated using a random walk process normalized to a standard deviation of 1 K, added to the air temperature plus 10 K.
  - rotational speed [rpm]: calculated from power of 2860 W, overlaid with a normally distributed noise
  - tool wear [min]: The quality variants H/M/L add 5/3/2 minutes of tool wear to the used tool in the process. and a
- **Training Process:**
  - 'machine failure' label that indicates, whether the machine has failed in this particular data point for any of the following failure modes are true.
- **Prediction Process:**
  - Algorithm makes predictions for Continuous input from live sensors (temperature, vibration, pressure)
  - Streaming data processed via edge computing or cloud platforms.

Result



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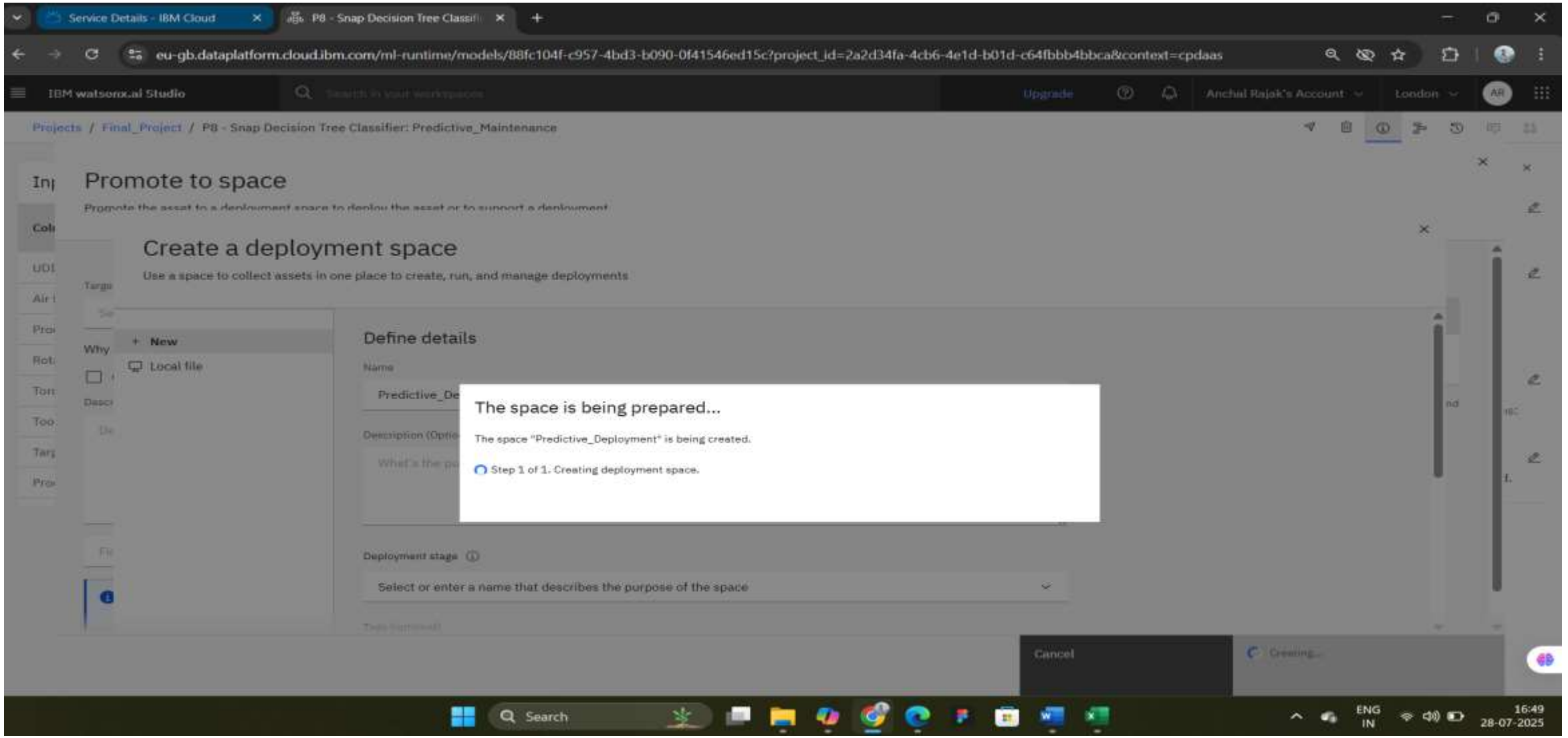
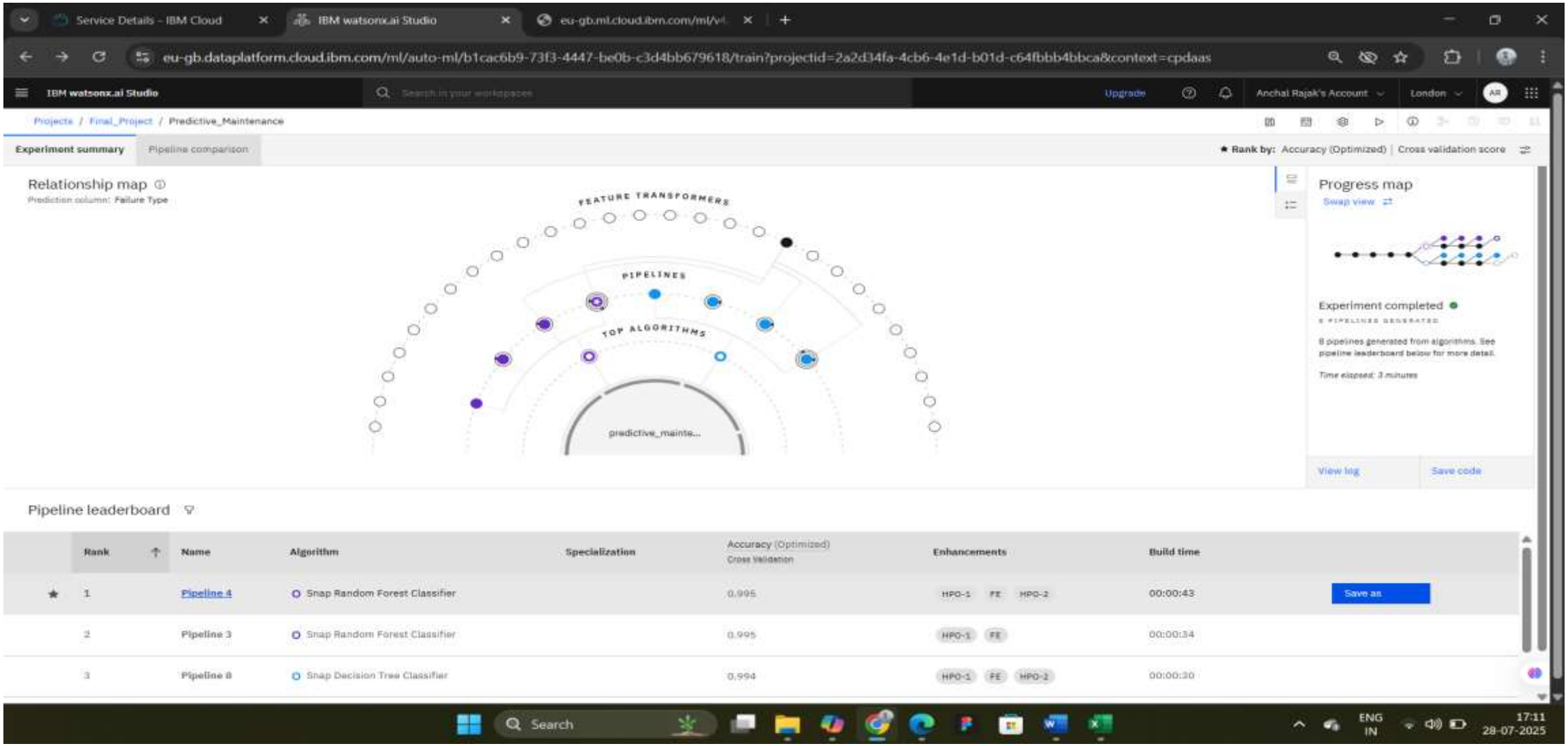
Result


Service Details - IBM Cloud
P8 - Snap Decision Tree Classifi
eu-gb.dataplatform.cloud.ibm.com/ml-runtime/models/88fc104f-c957-4bd3-b090-0f41546ed15c?project_id=2a2d34fa-4cb6-4e1d-b01d-c64fbbb4bbca&context=cpdaas
IBM watsonx.ai Studio
Upgrade
Anchal Rajak's Account
London
Projects / Final_Project / P8 - Snap Decision Tree Classifier: Predictive_Maintenance
Promote to space
Create a deployment space
Use a space to collect assets in one place to create, run, and manage deployments
New
Local file
Define details
Name
The space is being prepared...
The space "Predictive_Deployment" is being created.
Step 1 of 1. Creating deployment space.
Deployment stage
Select or enter a name that describes the purpose of the space
Cancel
Search
ENG
IN
16:49
28-07-2025

RESULT



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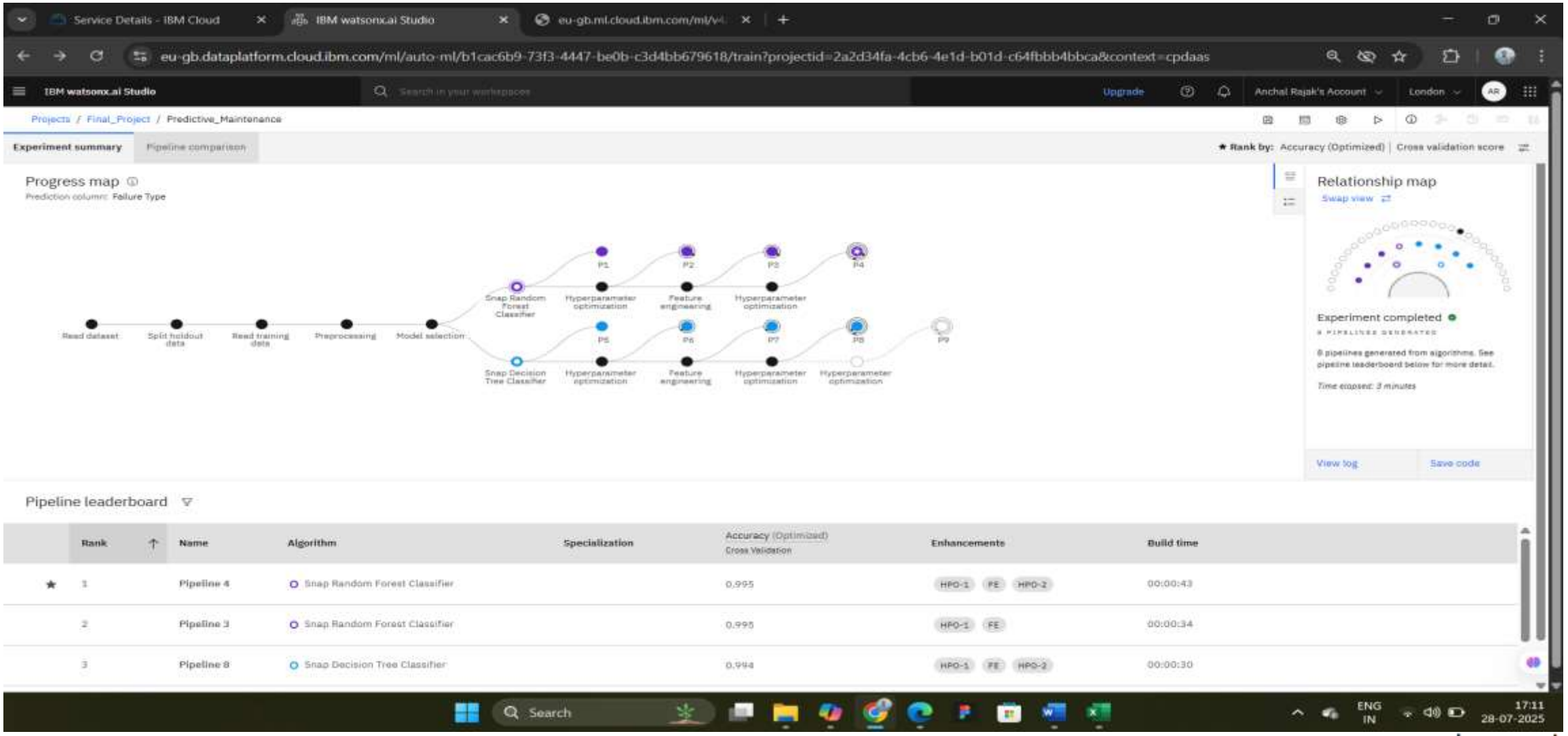
RESULT



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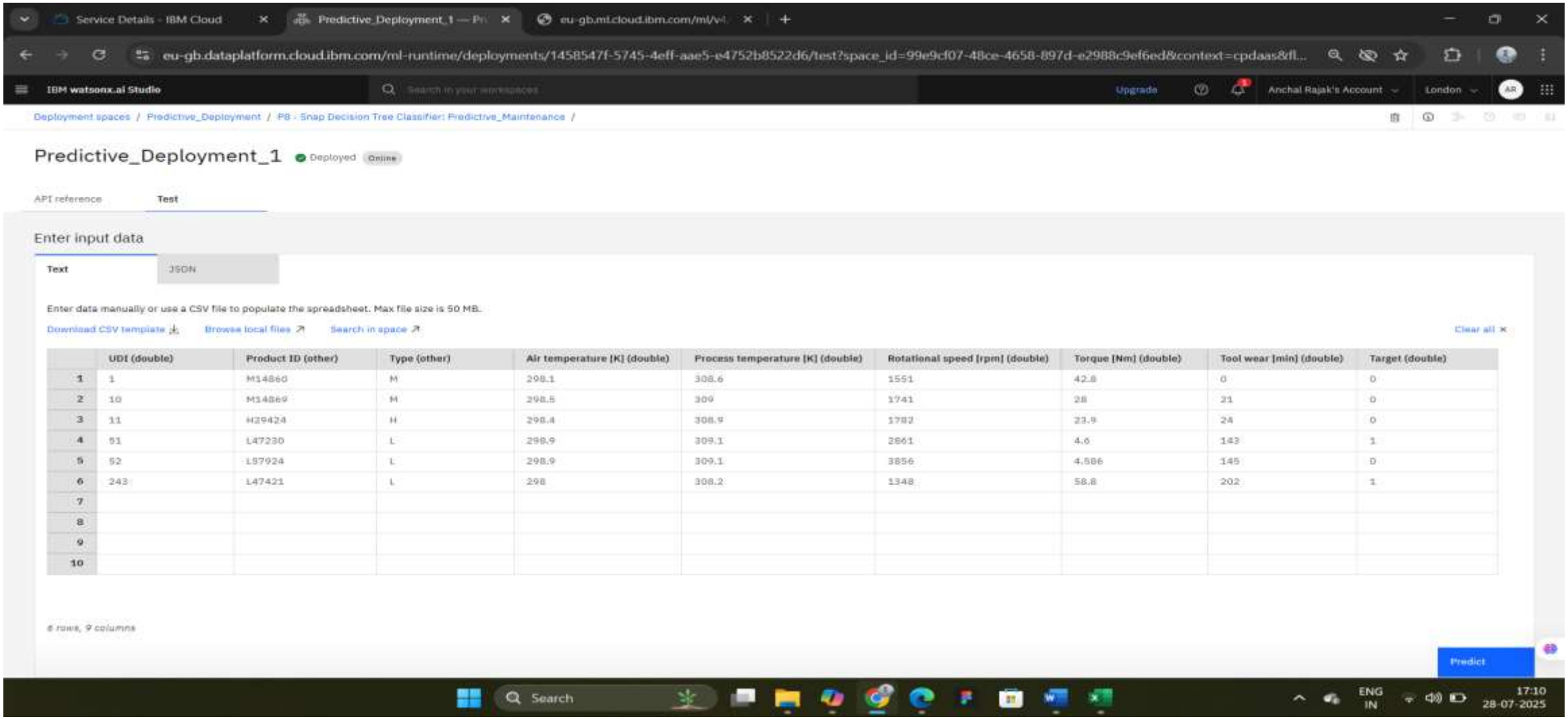
RESULT



	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)
1	1	M14860	M	298.1	308.6	1551	42.8	0	0
2	10	M14869	M	298.5	309	1741	28	21	0
3	11	H29424	H	298.4	308.9	1782	23.9	24	0
4	51	L47230	L	298.9	309.1	2861	4.6	143	1
5	52	L57924	L	298.9	309.1	3856	4.586	145	0
6	243	L47421	L	298	308.2	1348	58.8	202	1
7									
8									
9									
10									

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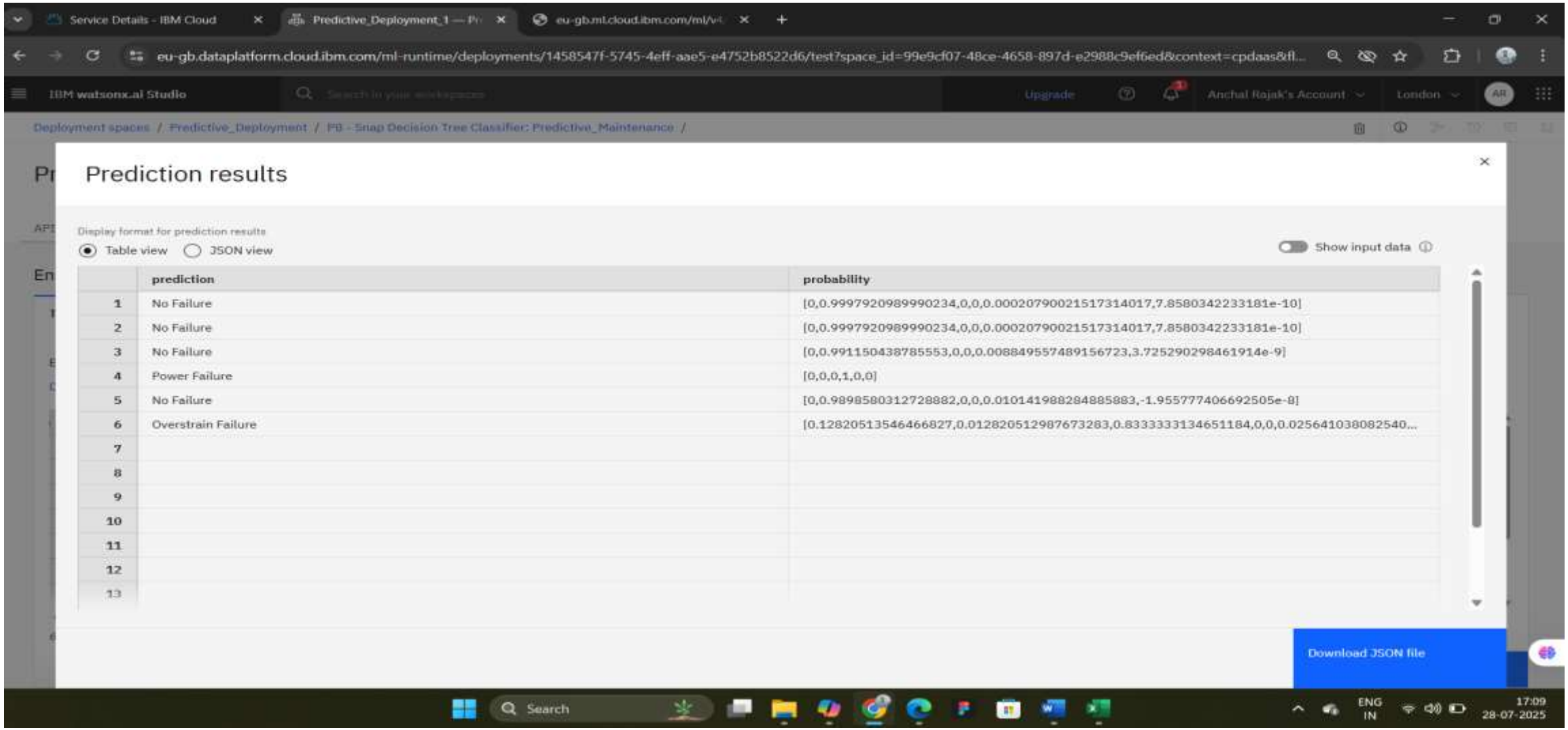
RESULT



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CONCLUSION

- This project demonstrates the power of machine learning in mechanical systems—whether predicting industrial failures or urban mobility trends. The predictive maintenance model enhances equipment longevity, while bike count forecasting supports smart city initiatives.

FUTURE SCOPE

- **Predictive Maintenance:**
  - Extend to other domains like HVAC systems or automotive diagnostics.
  - Integrate with IoT platforms for real-time monitoring and alerts.
- **Bike Demand Forecasting:**
- Collaborate with municipal bodies for deployment.
- Explore reinforcement learning for adaptive bike rebalancing strategies.

REFERENCES

- IBM Cloud Lite Services documentation.
- https://cloud.ibm.com/
- Email ID:- anchalrajak16@edunetmail.com
- Password:- Test@12345678
- My Github ID:- https://github.com/anchal-rajak4260?tab=repositories
- Kaggle Dataset:- Machine Predictive Maintenance Classification.
- Demonstrate successful integration of ML with IBM Cloud Lite services.

IBM CERTIFICATIONS

IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution

IBM

Anchal Rajak

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 17, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/85b1e7b3-b024-4bca-abb1-268362ad82a2

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IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Anchal Rajak

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 17 Jul 2025 (GMT)

Learning hours: 20 mins

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THANK YOU

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