CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

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OUTLINE

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PROBLEM STATEMENT

Predictive Maintenance of Industrial Machinery

- 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

- **Sensor Data Collection:**
  Collect real-time and historical sensor data from industrial machines, including parameters such as temperature, torque, speed, and tool wear.

- **Data Preprocessing:**
  Clean and preprocess the data to handle missing values and outliers. Apply normalization and feature encoding as needed.

- **Feature Engineering:**
  Extract meaningful features from raw sensor inputs that contribute to machinery failures (e.g., tool wear thresholds, speed anomalies).

PROPOSED SOLUTION

- **Machine Learning Model:**
  Utilize IBM AutoAI to automatically test, tune, and select the best classification model (e.g., Random Forest) for predicting failure types.

- **Deployment:**
  Deploy the best-performing model using IBM Watsonx.ai Studio. Enable users to input real-time machine data and get instant failure predictions.

- **Evaluation:**
  Assess model accuracy using cross-validation metrics (Accuracy: 99.5%). Continuously monitor and retrain if needed for improved reliability.

SYSTEM APPROACH

The System Approach outlines the technical environment and tools used to build the predictive maintenance system.

System Requirements

Software:

- IBM Cloud account
- IBM Watsonx.ai Studio
- IBM Cloud Object Storage
- Watson Online Deployment

Input Data:

Industrial sensor data (CSV format) which includes features such as Air Temp, Process Temp, Torque, Speed, Tool Wear, etc.

Output:

Predicted machine failure type (e.g., No Failure, Heat Dissipation, Power Failure)

ALGORITHM & DEPLOYMENT

Algorithm Used:

- Snap Random Forest Classifier
- It has high accuracy (99.5%) , Robust with structured sensor data ,Good for multi-class classification ,Handles complex relationships between features

Input Features:

- Product Name, Machine Type, Air & Process Temperature,Rotational Speed, Torque,Tool Wear etc.

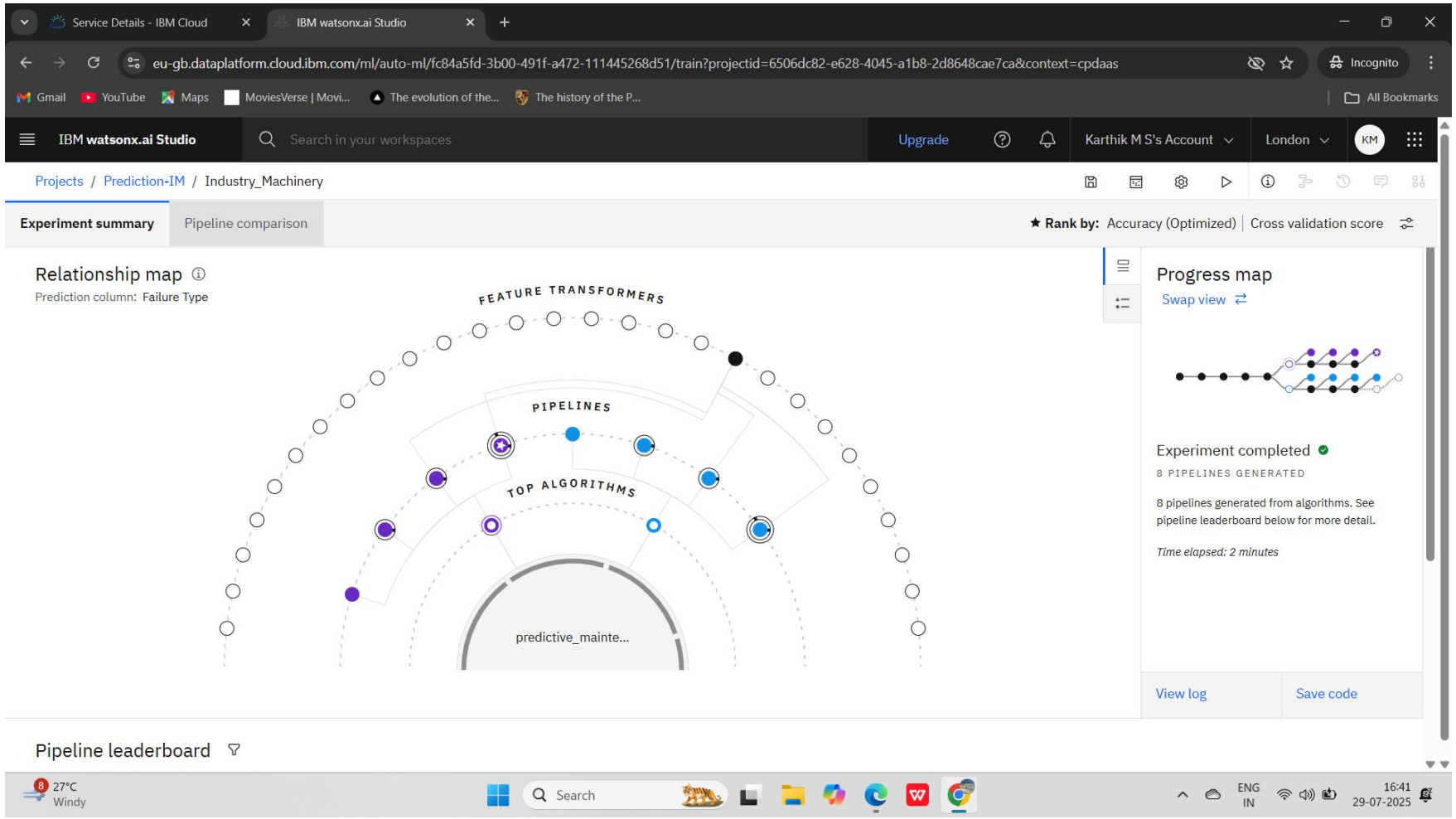
Training Process:

- AutoAI handled preprocessing, feature engineering, and model tuning
- Used cross-validation and hyperparameter optimization (HPO)

Prediction:

- Real-time failure type prediction
- Deployed on IBM Cloud for live input and output

RESULT



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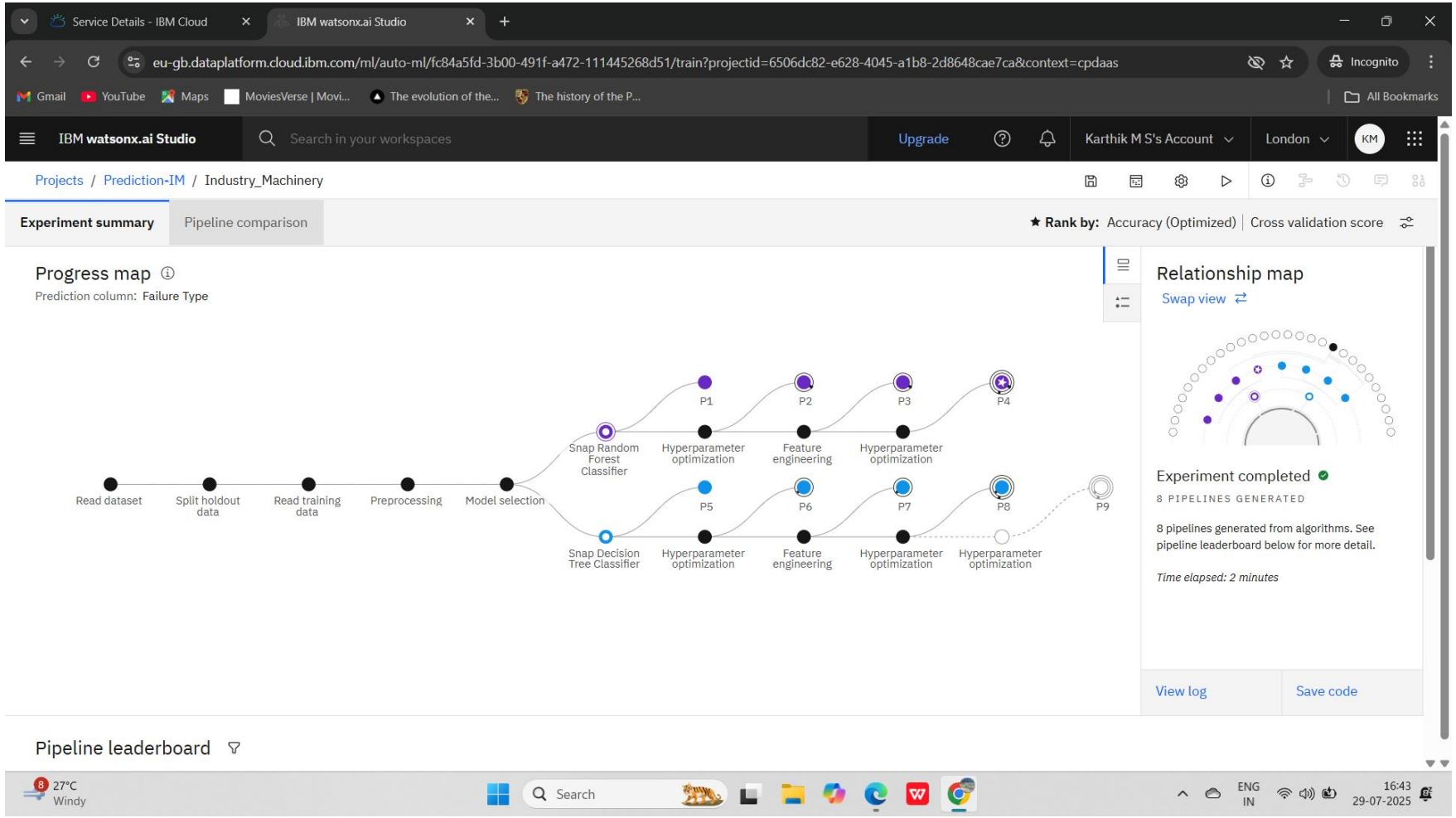
RESULT



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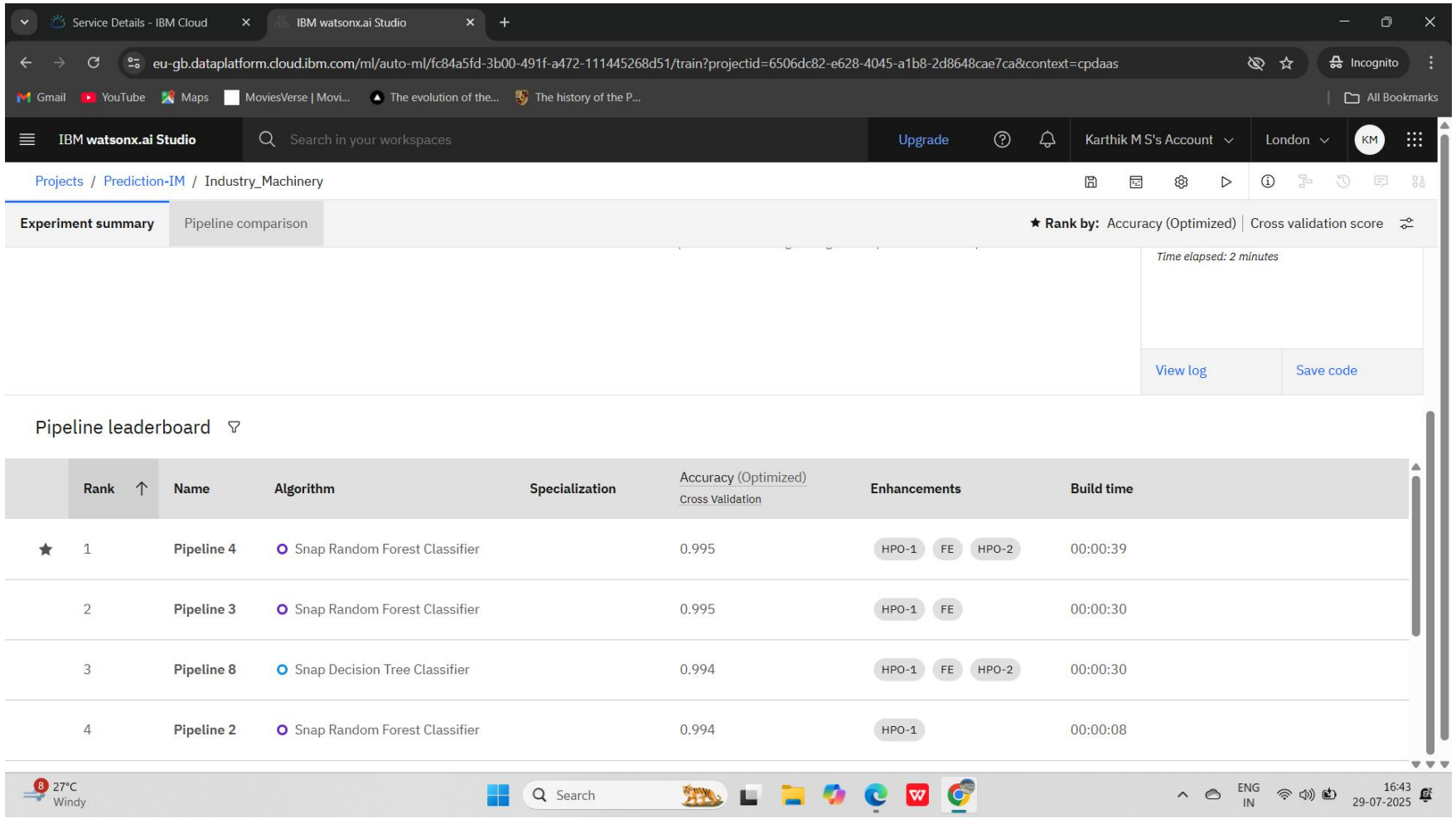
RESULT



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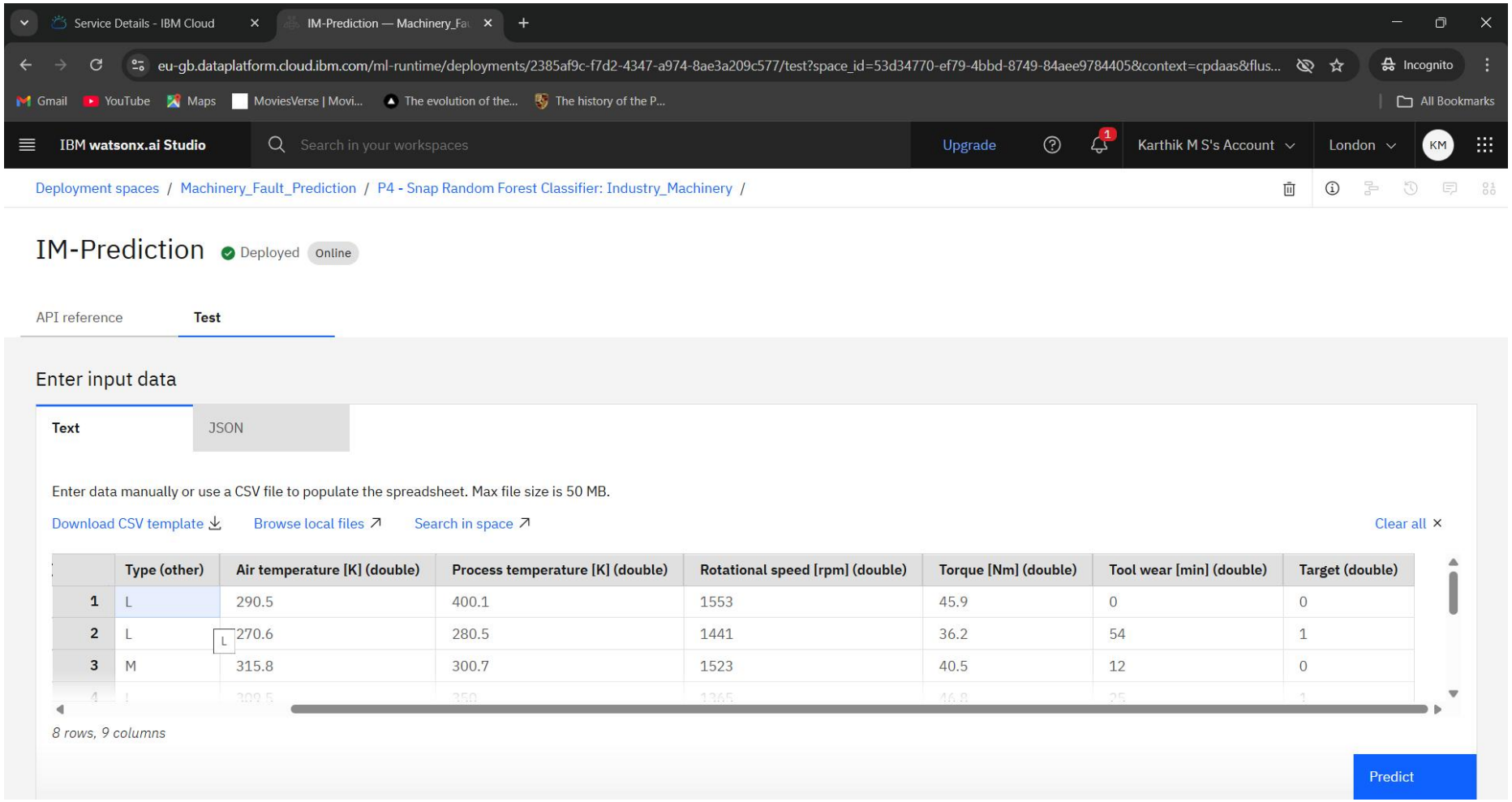
RESULT



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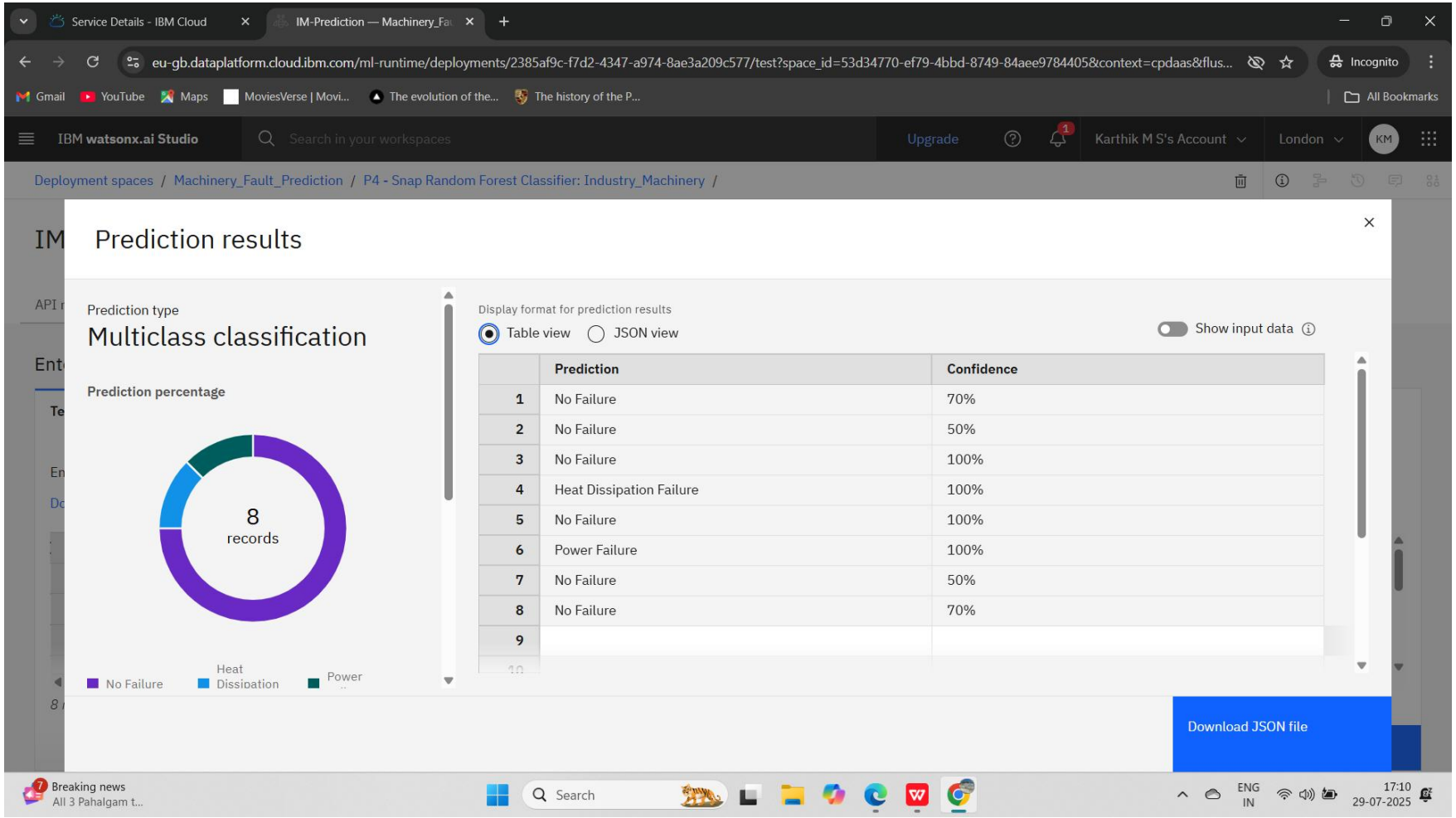
RESULT

Test data

UDI	Product ID	Type	Air tempera	Process tem	Rotational s	Torque [Nm	Tool wear [	Target
1	L58642	L	290.5	400.1	1553	45.9	0	0
2	L89421	L	270.6	280.5	1441	36.2	54	1
3	M98723	M	315.8	300.7	1523	40.5	12	0
4	L15489	L	309.5	350	1365	46.8	25	1
5	M36478	M	296.1	309	1523	36.9	24	0
6	L47230	L	298	309	2861	4.6	143	1
7	M25846	M	309.2	299	1400	43.7	19	1
8	H73485	H	320.7	290	1652	38.5	13	1

RESULT



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CONCLUSION

- Achieved 99.5% accuracy in predicting machine failures using IBM AutoAI.
- Enabled proactive maintenance, reducing machine downtime and operational costs.
- Ensured accurate classification of different failure types (e.g., tool wear, power failure).
- Faced challenges in understanding AutoAI workflow and interpreting multi-class predictions.
- Demonstrated the effectiveness of AI in improving industrial machinery reliability.

FUTURE SCOPE

- Add more data sources like vibration and maintenance logs.
- Use advanced ML models for better performance.
- Expand the system to multiple factories or regions.
- Explore deep learning and edge computing for real-time predictions.
- Build a dashboard with live alerts for maintenance teams.

REFERENCES

Kaggle Dataset:
Machine Predictive Maintenance Classification Dataset
https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

IBM Documentation:
IBM Watsonx.ai – AutoAI User Guide
https://www.ibm.com/docs/en/watsonx

IBM AutoAI Overview
https://www.ibm.com/cloud/watson-studio/autoai

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