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

Predictive maintenance leverages real-time sensor data to identify signs of machine failure before breakdowns occur. This project focuses on developing an AI-based model using IBM Cloud Lite services to analyze industrial machinery data, detect anomalies, and generate early alerts. The goal is to reduce unplanned downtimes, optimize maintenance schedules, and cost-effectively improve operational efficiency.

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PROPOSED SOLUTION

- **The proposed system aims to solve the challenge of predicting industrial machine failures in advance to minimize downtime and maintenance costs. This involves using AI/ML algorithms on sensor data to detect abnormal patterns. The solution will consist of the following components:**

Data Collection:

- Collect historical data from machinery sensors, including temperature, vibration, pressure, and power usage.
- Integrate real-time data streams from connected sensors for continuous monitoring. Use IBM Cloud Object Storage (Lite) to store datasets efficiently.

Data Preprocessing:

- Clean and standardize sensor data to handle missing values, noise, and outliers.
- Perform feature engineering to extract critical indicators like operating cycles, temperature shifts, and vibration spikes that signal wear and tear.

Machine Learning Algorithm:

- Implement machine learning models such as Random Forest, time-series models (like LSTM)
- Train the model to identify patterns that precede machinery failure. Consider contextual inputs like maintenance history, usage frequency, and environmental conditions.

Deployment:

- Develop a web-based dashboard to visualize machine health status and alert levels.

Evaluation:

- Assess model performance using metrics such as Precision, Recall, F1 Score. Continuously monitor predictions and retrain the model with new data for improved accuracy. Evaluate false positive/negative rates to ensure reliability.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the predictive maintenance model. Here's the suggested structure for this section :

- **IBM Cloud** (mandatory)
- **IBM Watson Studio** for model development, training, and deployment.
- **IBM Cloud Object Storage** for storing historical and real-time sensor data.
- **IBM Watson Machine Learning** for deploying and accessing the model via API

ALGORITHM & DEPLOYMENT

- ## Algorithm Selection:

  Random Forest Classifier (due to its accuracy and interpretability)
  Optional: LSTM for sequence-based time-series predictions

- ## Data Input:

Dataset from Kaggle including sensor features like Air Temperature, Process Temperature, Rotational Speed, Torque, Tool Wear, and Machine Failure (target label).

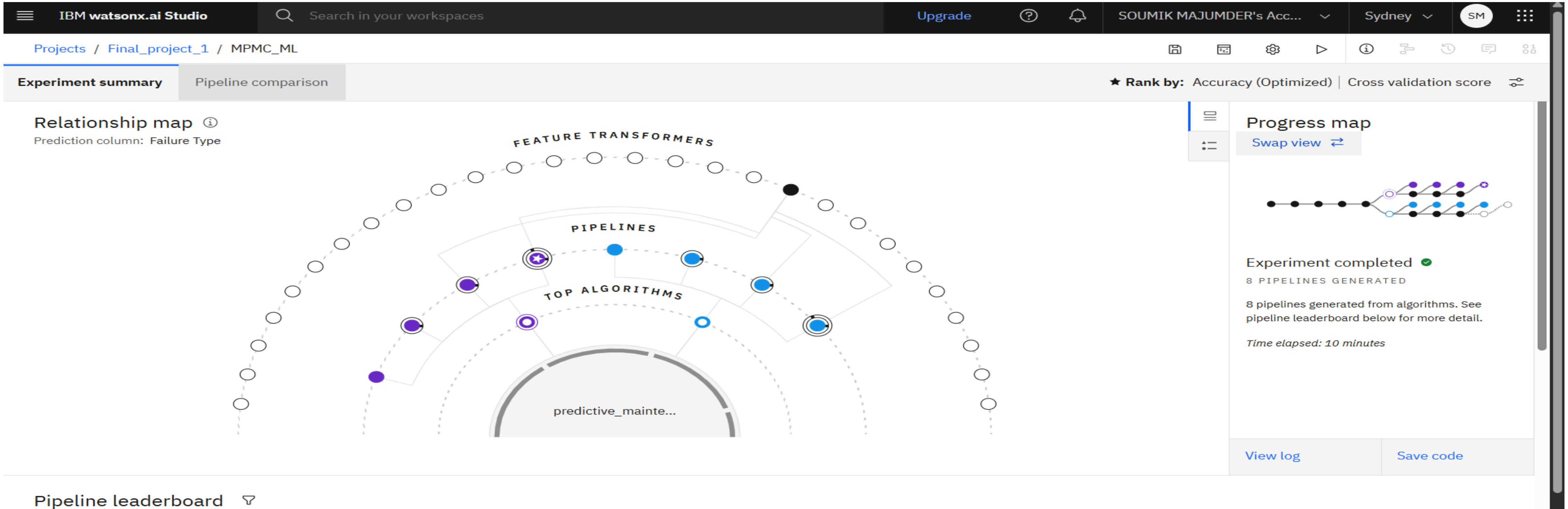
- ## Training Process:

  The model was trained in IBM Watson Studio. Labeled dataset used for supervised model training.

- ## Prediction Process:

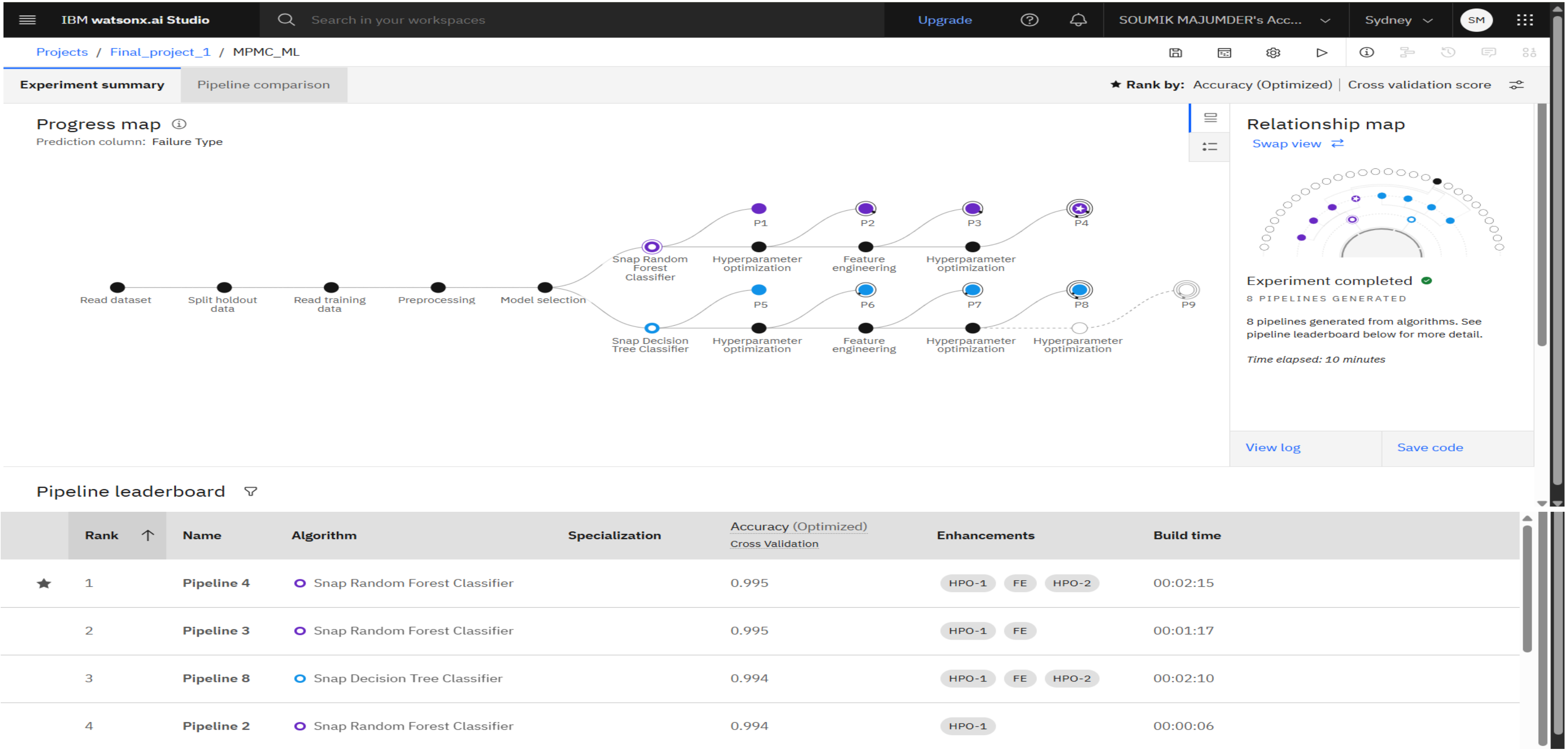
  Trained model deployed using **IBM Watson Studio.** API endpoint integrated with a monitoring interface for real-time predictions

RESULT



	Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 4	Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:02:15
	2	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:01:17
	3	Pipeline 8	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:02:10
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:06

RESULT



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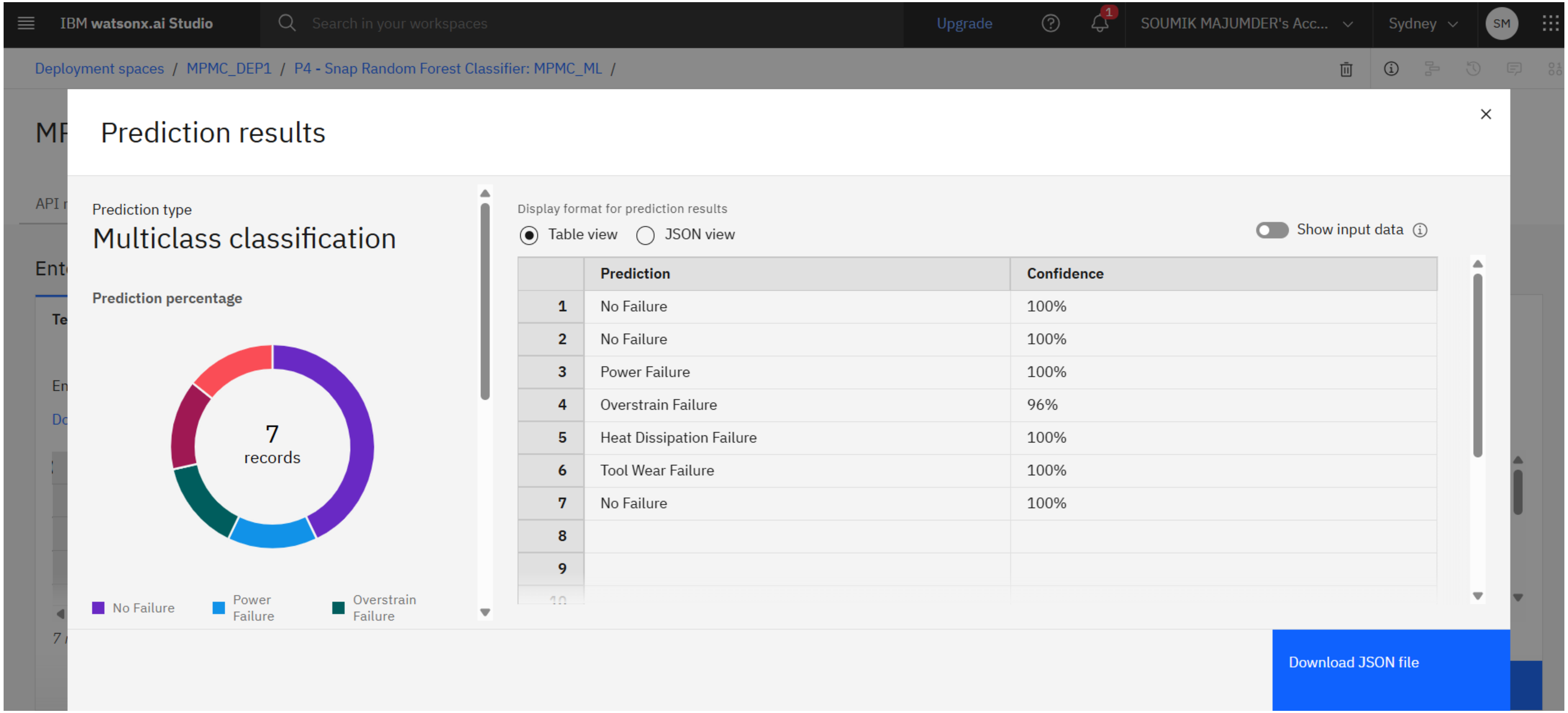
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:06

RESULT


IBM watsonx.ai Studio
Search in your workspaces
Upgrade
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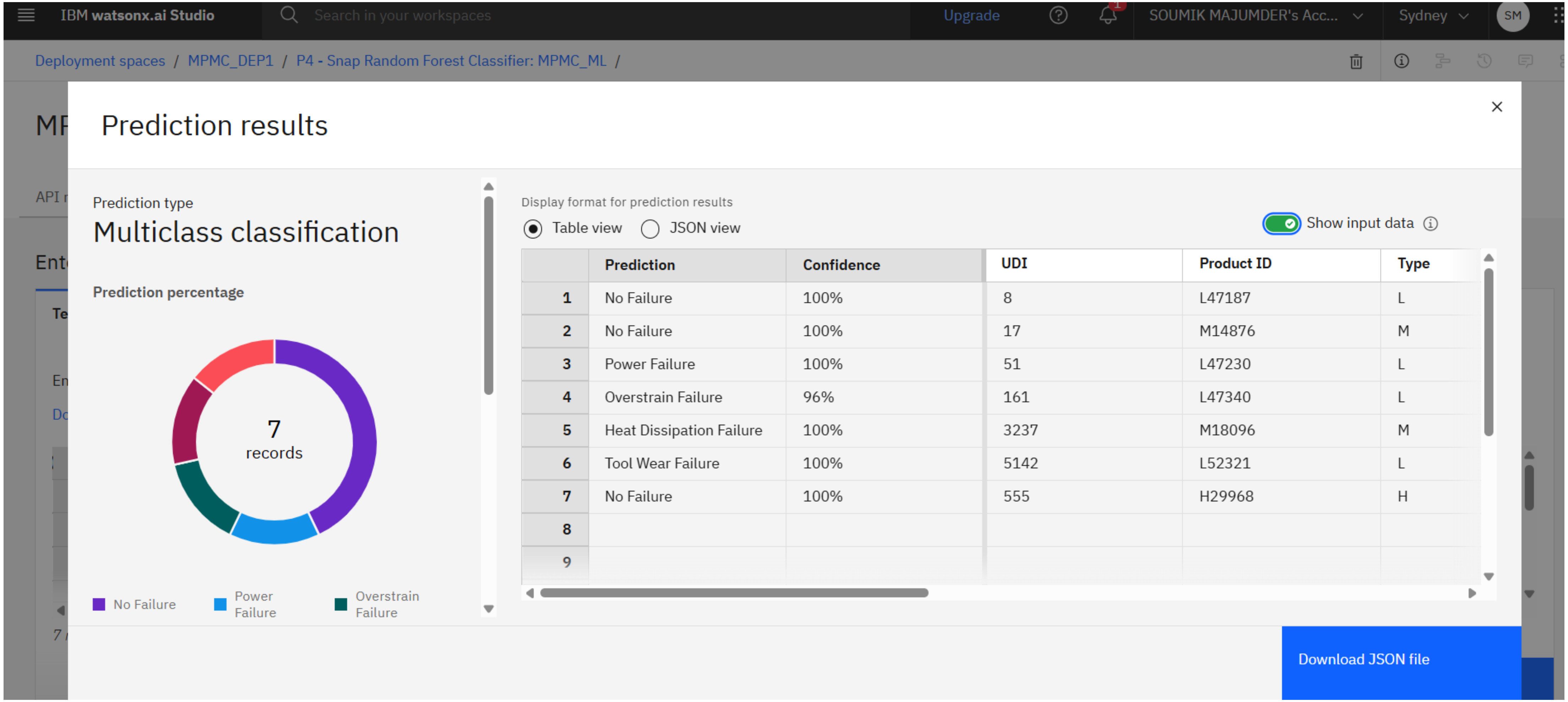
Sydney
SM
Deployment spaces / MPMC_DEP1 / P4 - Snap Random Forest Classifier: MPMC_ML /
Prediction results
Prediction type
Multiclass classification
Prediction percentage
7
records
No Failure
Power Failure
Overstrain Failure
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 No Failure 100%
2 No Failure 100%
3 Power Failure 100%
4 Overstrain Failure 96%
5 Heat Dissipation Failure 100%
6 Tool Wear Failure 100%
7 No Failure 100%
8
9
Download JSON file

RESULT



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CONCLUSION

- The developed predictive maintenance model successfully identifies early signs of machine failure using sensor data and machine learning. By leveraging IBM Cloud Lite services, the solution remains cost-effective and scalable. This system helps reduce unexpected downtimes, improve machine reliability, and support smart industry transformation with minimal resources.

FUTURE SCOPE

- The system can be enhanced by integrating real-time IoT sensor data for live predictions, expanding to different types of machinery, and improving model accuracy using deep learning techniques like LSTM. It can also be extended to mobile platforms and connected with existing industrial ERP systems for end-to-end maintenance automation.

REFERENCES

- Kaggle Dataset – Predictive Maintenance:

  https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification?resource=download

- IBM Watson Studio Documentation:

  https://www.ibm.com/cloud/watson-studio

- IBM Cloud Functions & Lite Services:
  https://www.ibm.com/cloud/functions
  https://www.ibm.com/cloud/free

- LSTM Neural Networks – Towards Data Science:
  https://towardsdatascience.com/lstm-by-example-using-tensorflow-feb0c1968537

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