
CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

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OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result (Output Image)
- Conclusion
- 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

- **Proposed System**
- The proposed system focuses on predicting industrial machine failures using IBM Cloud and Watsonx.ai Studio to enable proactive maintenance and reduce downtime.
- **1. Data Collection**
- Collected historical sensor data from industrial machines (Kaggle dataset).
- Data includes parameters such as temperature, vibration, torque, rotational speed, voltage, and pressure.
- **Data Preprocessing:**
 - Cleaned and normalized data by handling missing values, outliers, and inconsistent formats.
 - Performed feature engineering (rolling averages, correlations) and split data into train/test sets.
- **Machine Learning Algorithm:**
 - Trained models (Random Forest, XGBoost, Logistic Regression) in Watsonx.ai Studio.
 - Applied hyperparameter tuning and cross-validation to select the best-performing model.

PROPOSED SOLUTION

- **Deployment:**

- Deployed the final model on Watsonx.ai Runtime and created a REST API for real-time predictions.
- Integrated IBM Cloud Object Storage for automated input data handling and updates.

- **Evaluation:**

- Evaluated using Accuracy, Precision, Recall, and F1-score with a confusion matrix.
- Implemented continuous monitoring and periodic retraining to maintain performance.

- **Result:**

- Evaluated using Accuracy, Precision, Recall, and F1-score with a confusion matrix.
- Implemented continuous monitoring and periodic retraining to maintain performance.

SYSTEM APPROACH

- **System requirements**
- **Hardware:**
- Minimum 4-core CPU, 8 GB RAM
- 20 GB free disk space
- Stable internet connection for IBM Cloud access
- **Software:**
- IBM Cloud account with Watsonx.ai Studio and Runtime enabled IBM Cloud Object Storage
- Library required to build the model
- **Library Requirements:**
- Kaggle dataset: Machine Predictive Maintenance Classification Dataset
- <https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification>

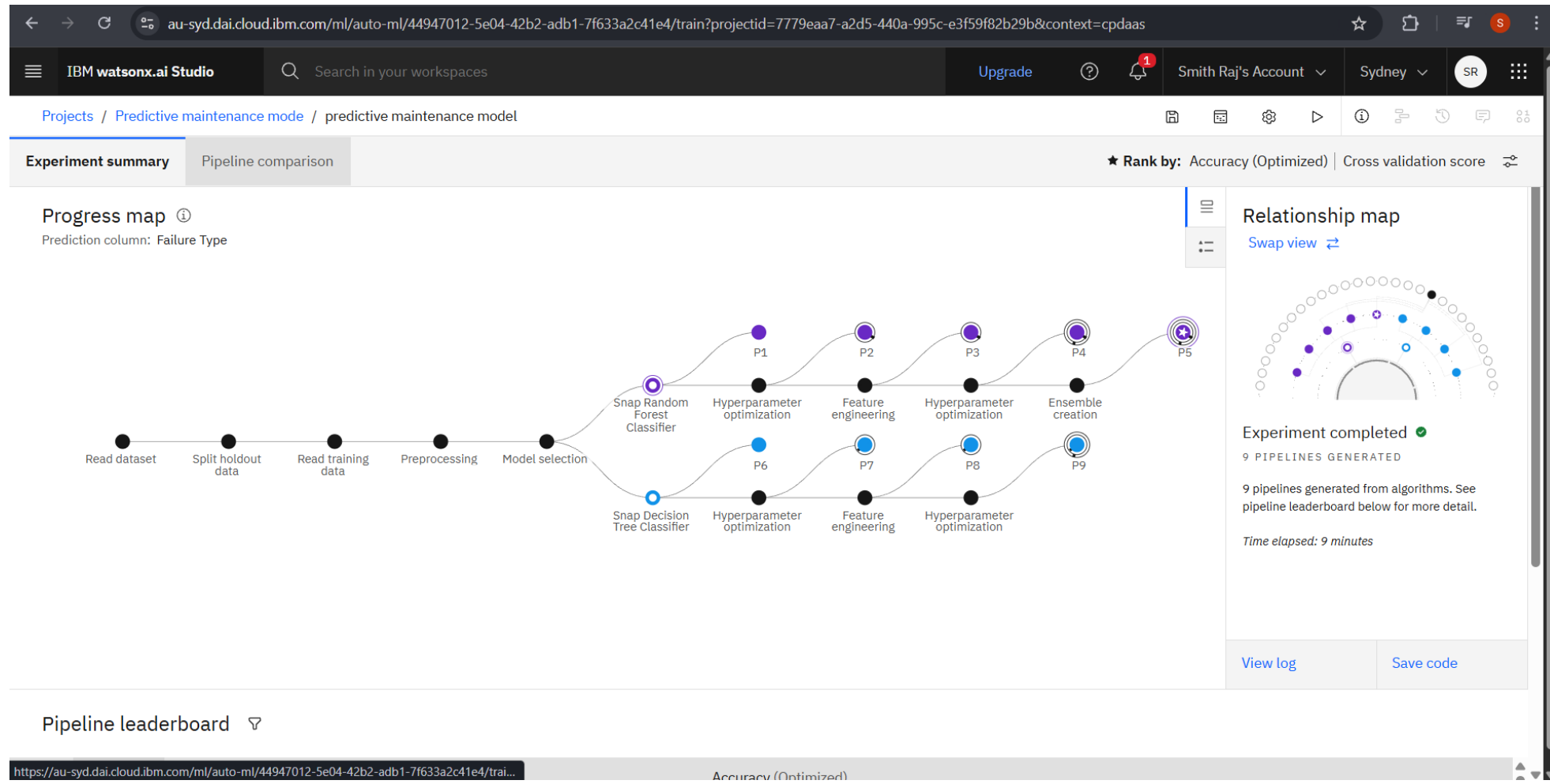
ALGORITHM & DEPLOYMENT

- **Algorithm (Machine Learning)**
- **Algorithm Selection:**
 - Tested multiple algorithms: Random Forest, XGBoost, and Logistic Regression.
 - Selected the best model based on evaluation metrics (Accuracy, F1-Score).
- **Data Input** : Real-time and historical sensor data (temperature, torque, vibration, speed, voltage).
- Data preprocessed (cleaning, normalization, feature engineering) before feeding into the model.
- **Training Process** : Used Watsonx.ai Studio for training with hyperparameter tuning and cross-validation.
- Trained the model on labeled failure data to learn patterns indicating machine issues.

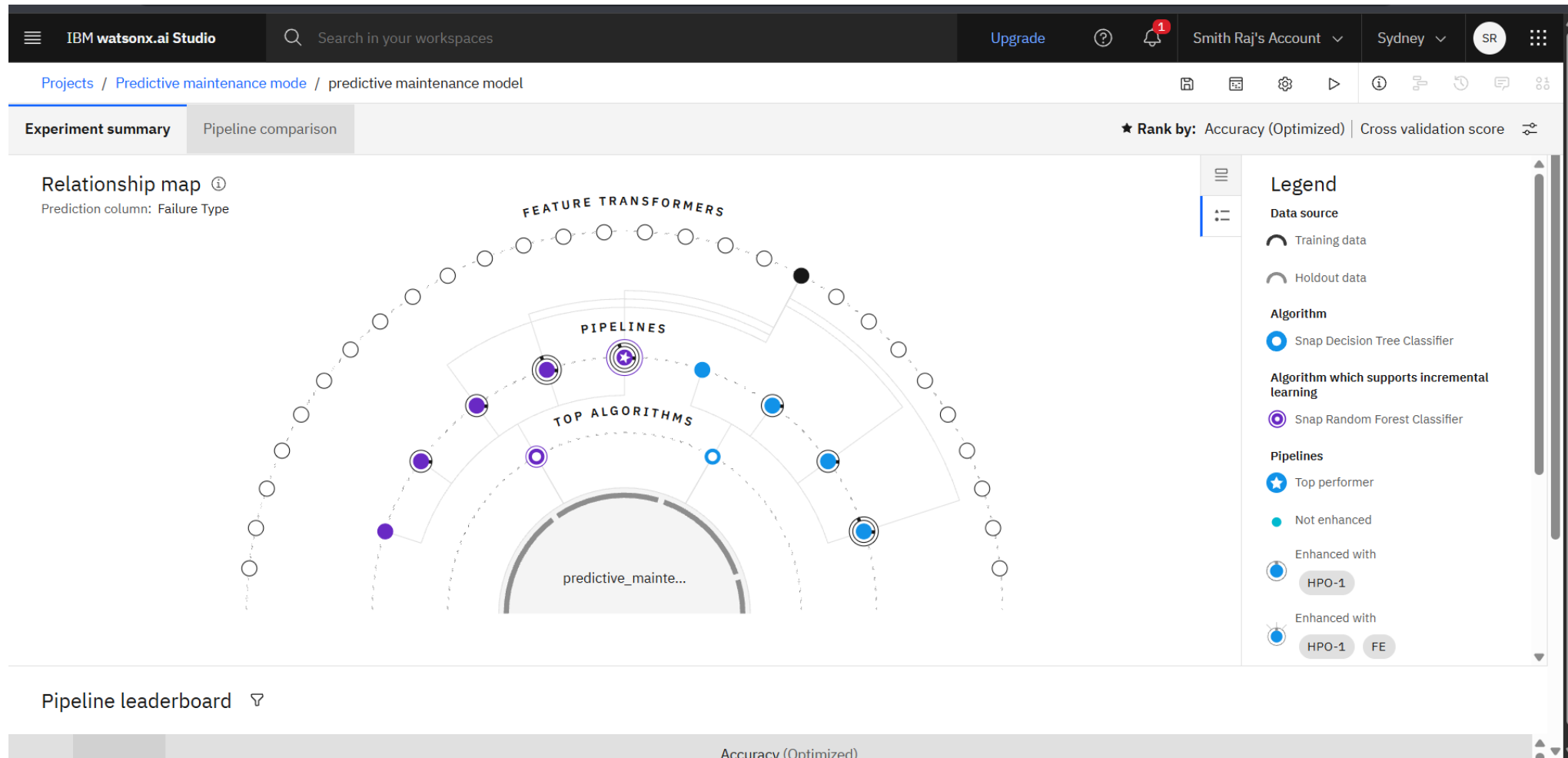
ALGORITHM & DEPLOYMENT

- **Prediction Process** :The trained model predicts failure type (tool wear, power failure, heat dissipation) from live sensor input.
- Outputs prediction with confidence score for proactive maintenance action.
- **Deployment:**
- **Cloud Deployment** : Deployed the trained model using Watsonx.ai Runtime Services in IBM Cloud.
- Created a REST API endpoint to enable real-time prediction integration with applications.
- **Data Handling** : Connected IBM Cloud Object Storage for storing input/output data.
- Enabled automated updates and re-training with new incoming data for continuous improvement.

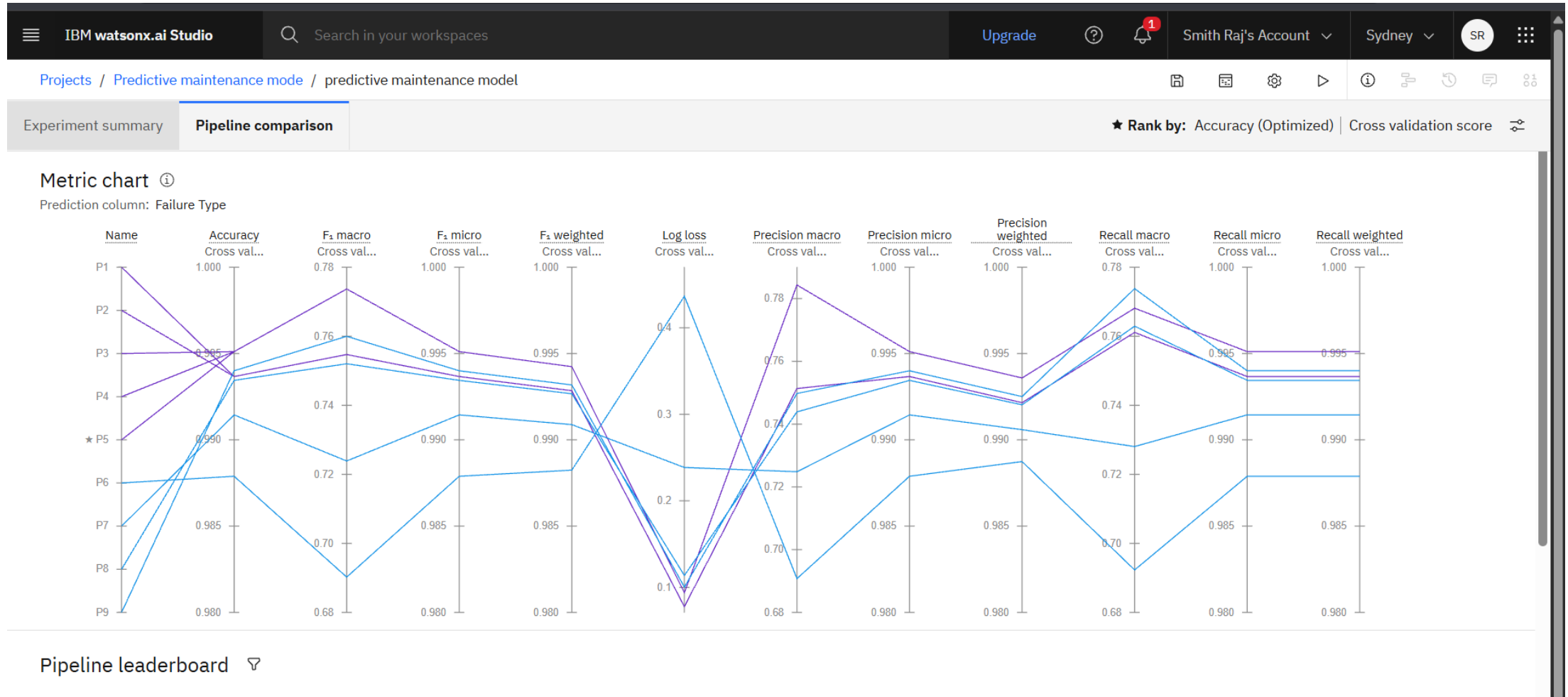
RESULT



RESULT








RESULT



RESULT

Pipeline leaderboard

	Rank 	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 5	 Batched Tree Ensemble Classifier (Snap Random Forest Classifier)	INCR	0.995	HPO-1 FE HPO-2 BATCH	00:01:41
	2	Pipeline 4	 Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:00:47
	3	Pipeline 3	 Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:39
	4	Pipeline 9	 Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:03

RESULT

predictive maintenance model ✓ Deployed Online

API reference

Test

Enter input data

Text

JSON

Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.

[Download CSV template](#) ⬇

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	UDI (double)	Product ID (other)	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)	Tool wear
1	51	L47230	L	300	310	2861	4.6	143
2	78		L	298	309	1360	60.8	187
3	78	L47257	L	298.8	308.9	1455	41.3	208
4	50		M	44		24	32	100
5								

4 rows, 9 columns

Predict

RESULT

Prediction results

Display format for prediction results

☒ Table view

☐ JSON view

Show input data

	prediction	probability
1	Power Failure	[0,0.1,0,0.9,0,0]
2	Overstrain Failure	[0.0030303031206130983,0,0.9969696998596191,0,0,-2.9802322831784522e-9]
3	Tool Wear Failure	[0,0,0,0,0,1]
4	Heat Dissipation Failure	[0.9,0,0,0,0,0.09999999999999998]
5		
6		
7		
8		
9		
10		
11		

Download JSON file

CONCLUSION

- **Conclusion**
- The predictive maintenance system developed using **IBM Cloud and Watsonx.ai Studio** successfully predicts industrial machine failures in advance.
- By analyzing real-time sensor data and classifying failure types, the solution reduces unplanned downtime, lowers operational costs, and enhances machine reliability.

REFERENCES

- Kaggle. Predictive Maintenance Dataset. Available at: <https://www.kaggle.com> IBM Cloud.
- Watsonx.ai Studio Documentation. Available at: <https://www.ibm.com/cloud/watsonx> IBM Cloud.
- Object Storage Documentation. Available at: <https://cloud.ibm.com/docs/cloud-object-storage>

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THANK YOU