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

- The proposed system is a **Predictive Maintenance Model** designed to forecast potential machinery failures before they occur. It leverages historical sensor data from industrial machines and utilizes machine learning algorithms to classify and predict failure types. The system ensures minimal downtime and proactive maintenance by alerting stakeholders about the type of machinery fault in advance.
- **Key Features:**
- Reads and preprocesses training and test datasets.
- Automatically selects and optimizes suitable models.
- Applies advanced feature engineering and hyperparameter tuning.
- Classifies failure types accurately based on learned patterns.

SYSTEM APPROACH

- System Requirement : Window 10/11,8GB RAM
- Technology Used :IBM Cloud Lite Version

ALGORITHM & DEPLOYMENT

Algorithm Used:

- **Primary Models:**
  - Snap Random Forest Classifier
  - Snap Decision Tree Classifier
- **Optimization Techniques:**
  - **Hyperparameter Optimization** (multiple stages)
  - **Feature Engineering** to enhance prediction accuracy

ALGORITHM & DEPLOYMENT

- The best-performing pipeline (P4) uses Random Forest Classifier with repeated tuning and feature engineering. It was **ranked highest based on optimized accuracy**.
- **Deployment:**
- Built using **IBM Watsonx.ai Studio**, which provides an automated machine learning (AutoAI) pipeline.
- 8 pipelines were generated and compared using **cross-validation** and accuracy metrics.
- The final optimized model can be **deployed as an API** or **integrated into manufacturing systems** for real-time failure prediction.

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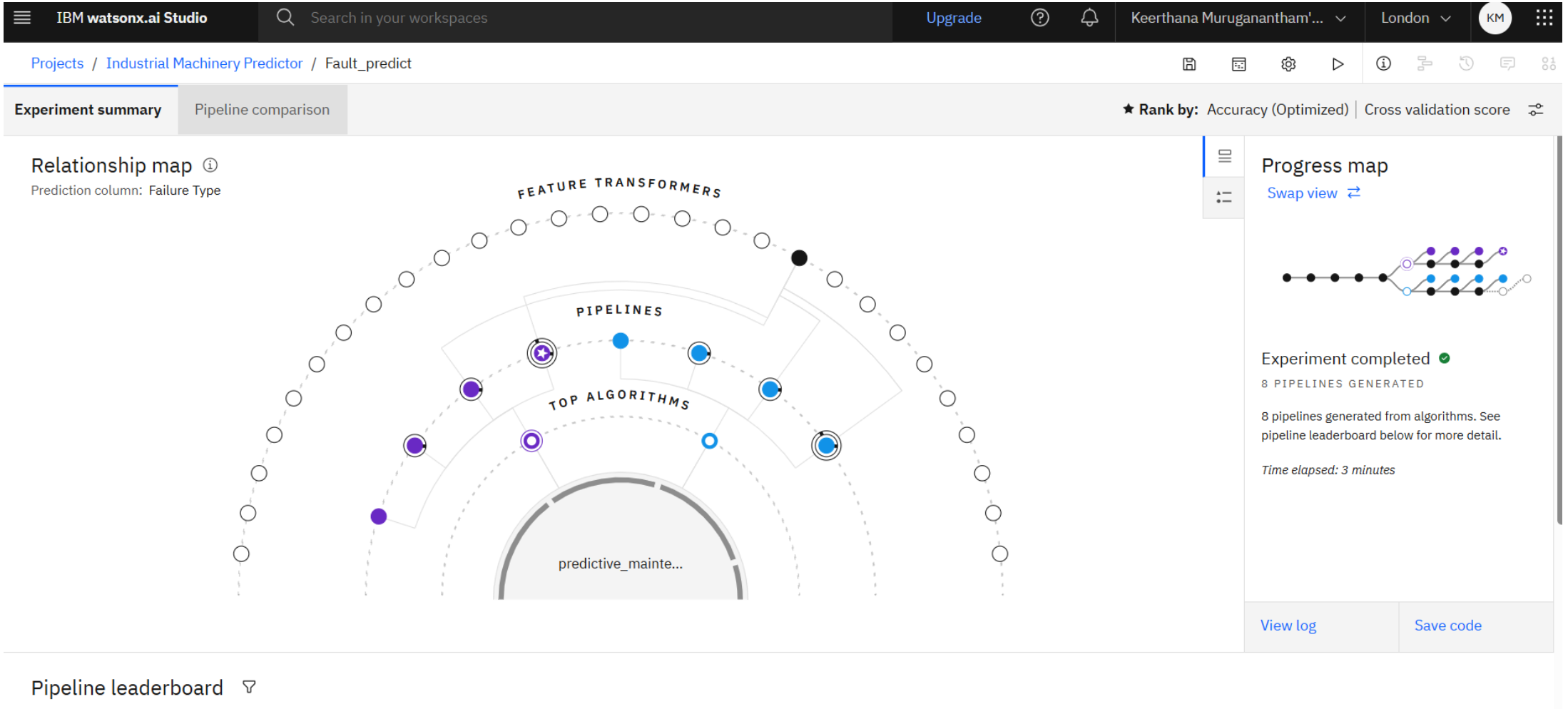
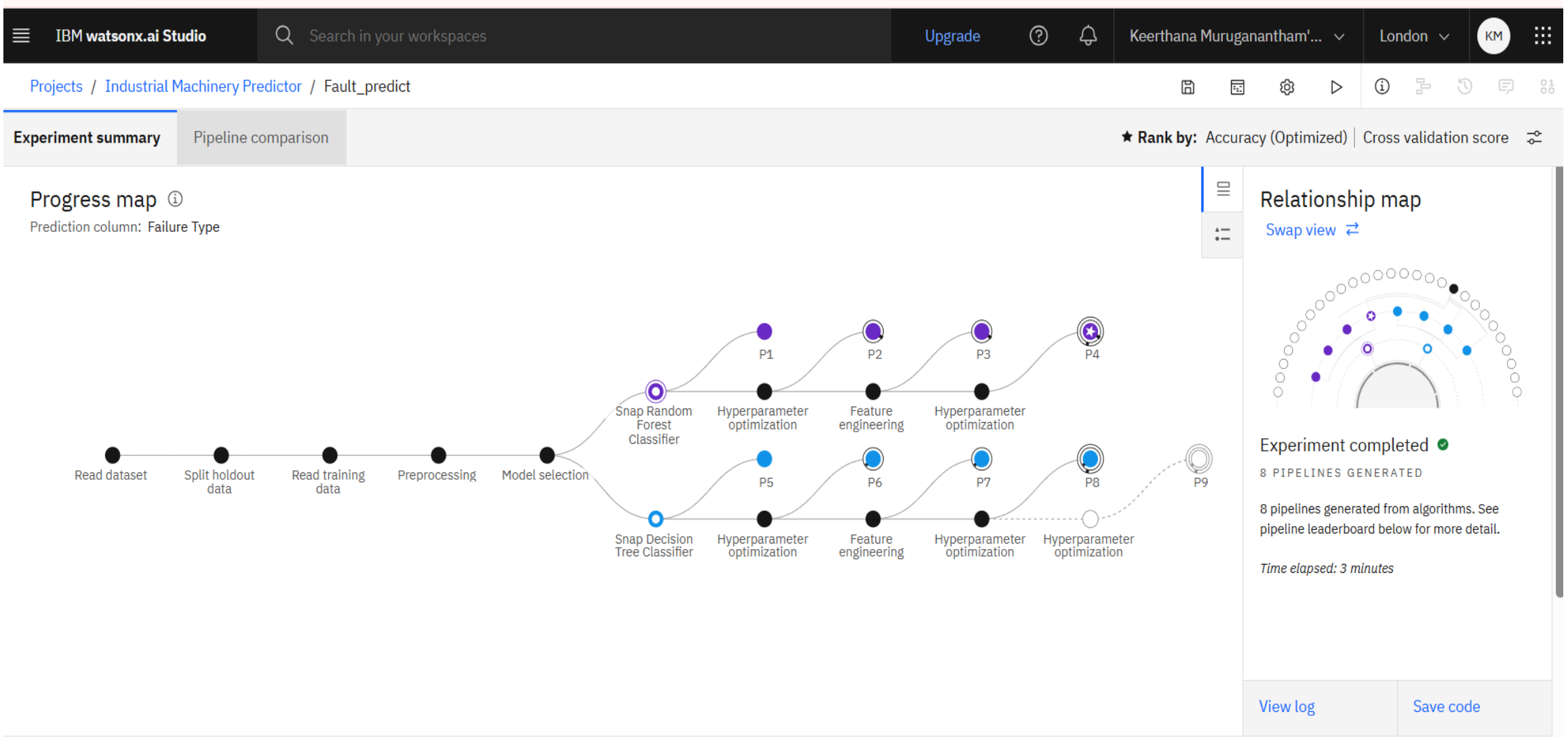
RESULT



RESULT



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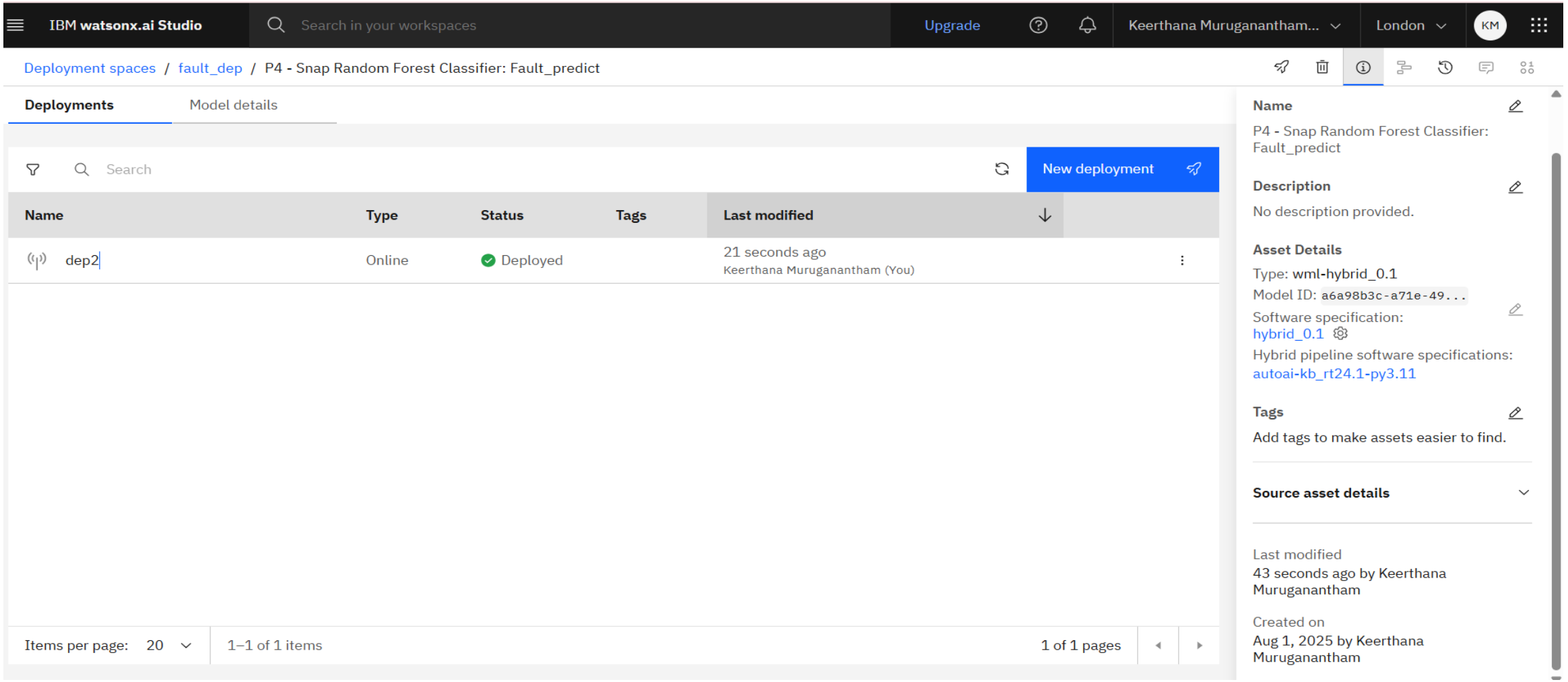
RESULT

Pipeline leaderboard

	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	00:00:41	Save as
	2	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:32	
	3	Pipeline 8	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:30	
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:08	

RESULT



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RESULT

Prediction results

Prediction type

Multiclass classification

Prediction percentage

No Failure

Confidence level distribution

Display format for prediction results

(•) Table view ( ) JSON view

Show input data

	Prediction	Confidence
1	No Failure	100%
2		
3		
4		
5		
6		
7		
8		
9		
10		

Download JSON file

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CONCLUSION

- The predictive maintenance system effectively demonstrates how machine learning can revolutionize industrial operations by minimizing unplanned downtimes and optimizing asset life. Using IBM Watsonx's AutoAI, the model pipeline was automatically built, optimized, and evaluated within minutes, making it a scalable solution for the manufacturing industry. The system provides accurate fault classification and sets a solid foundation for more intelligent, connected, and proactive machinery maintenance in the future.

FUTURE SCOPE

- **Integration with IoT Devices**: Real-time sensor data from IoT-enabled machinery can be fed directly into the model.
- **Adaptive Learning**: Implement online learning techniques to allow the model to improve over time with new data.
- **Edge Deployment**: Optimize the model for edge devices to ensure predictions even in low-connectivity areas.
- **Explainability and Alerts**: Integrate tools like SHAP or LIME to explain predictions and trigger alerts for critical failures.
- **Dashboard Integration**: Build dashboards for monitoring machine health status visually using tools like IBM Cognos or Power BI.

REFERENCES

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Available at: https://www.ibm.com/docs/en/watsonx

- **Scikit-learn: Machine Learning in Python**

Pedregosa et al., *Scikit-learn: Machine Learning in Python*, Journal of Machine Learning Research, 2011.
Available at: https://scikit-learn.org/stable/

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- **Random Forest and Decision Tree Classifiers**

Breiman, L. *Random Forests*. Machine Learning, 2001. DOI: 10.1023/A:1010933404324

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- **IBM Knowledge Center: Watsonx AutoAI**

IBM Knowledge Center. *Understanding AutoAI pipelines and model evaluation*. Available at: https://dataplatform.cloud.ibm.com/docs/content/wsj/autoai/

IBM CERTIFICATIONS

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In recognition of the commitment to achieve professional excellence

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THANK YOU

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