CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY (MACHINE LEARNING)

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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 predictive maintenance system will utilize machine learning to forecast and classify possible failures within industrial machinery.
- **Key Components:**
- Data Collection:
  Collect historical and real-time sensor data: temperature, vibration, voltage, pressure, and operational logs.
- Data Preprocessing:
  Clean data, address missing values, and engineer features that are strong predictors of failure modes.
- Model Development:
  Build a classification model (e.g., Random Forest, Logistic Regression, SVM) to predict specific failure types (tool wear, heat dissipation, power failure, etc.) leveraging the dataset from Kaggle.
- Deployment:
  Deploy the model on IBM Cloud Lite using IBM Watson Machine Learning for real-time analytics and prediction.
- Monitoring & Evaluation:
  Evaluate using metrics such as accuracy, F1-score, recall, and precision; monitor the deployed model for continuous improvement.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the Machine Predictive Maintenance Classification. Here's a suggested structure for this section:

- Software:
  - IBM Cloud (Mandatory).
  - IBM Watson studio for model development and deployment.
  - IBM cloud object storage for dataset handling.

- Hardware:
  - Computer with stable internet.

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Random Forest Classifier.

  - **Data Input:**
  - UDI, Product ID, Air temperature [K], Rotational speed [rpm], Tool wear [min], Target.

- **Training Process:**
  - Supervised learning using labelled fault types.

  - **Prediction Process:**
  - Model deployed on IBM Watsonx studio with API endpoint for real-time Predictions.

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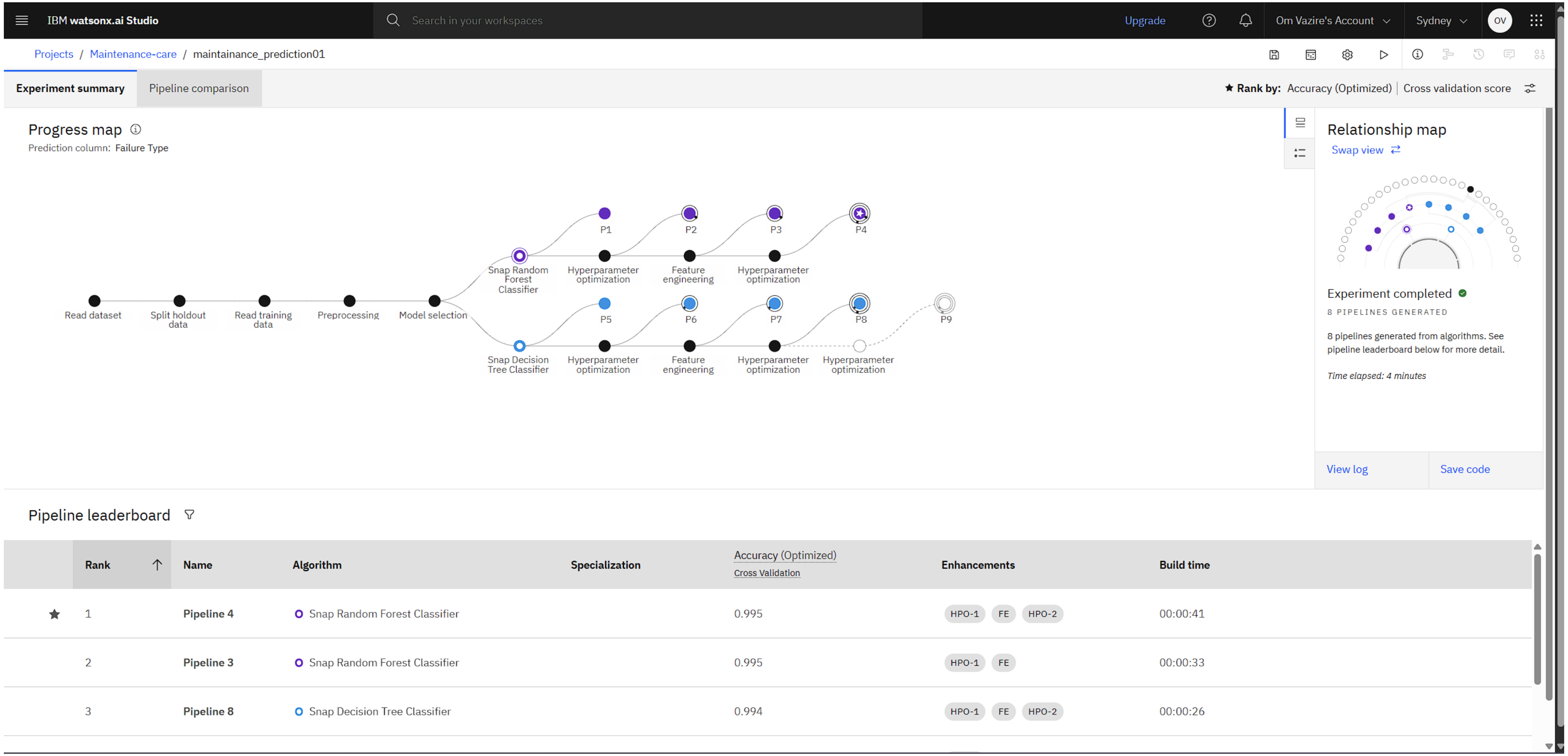
RESULT



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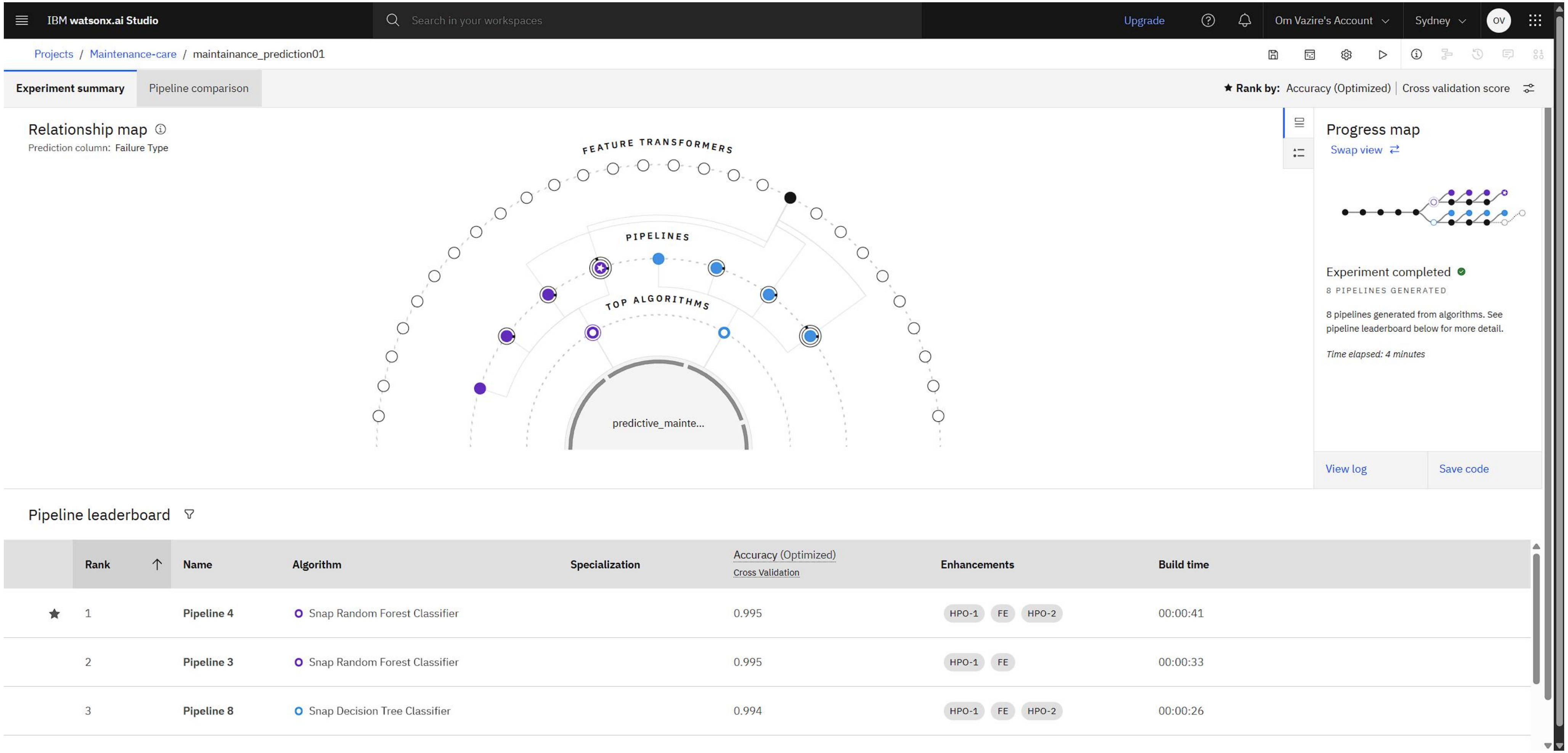
RESULT


IBM watsonx.ai Studio
Search in your workspaces
Upgrade
Om Vazire's Account
Sydney
OV
Projects / Maintenance-care / maintainance_prediction01
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Failure Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
predictive_mainte...
Progress map
Swap view
Experiment completed
8 PIPELINES GENERATED
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 4 minutes
View log
Save code
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
2 Pipeline 3 Snap Random Forest Classifier 0.995 HPO-1 FE 00:00:33
3 Pipeline 8 Snap Decision Tree Classifier 0.994 HPO-1 FE HPO-2 00:00:26

RESULT

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Om Vazire's Account | Sydney | OV

Deployment spaces / Maintainance-prediction_deployment / P4 - Snap Random Forest Classifier: maintainance_prediction01 /

maintainance_dep

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 | Browse local files | Search in space | Clear all

	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	51	L47230	L	298.9	309.1	2861	4.6	143	1
2	78	L47257	L	298.8	308.9	1455	41.3	208	1
3	89	M14948	M	299	309	1419	45.2	27	0
4	243	L47422	L	298	308.2	1348	58.8	202	1
5									
6									
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8									
9									
10									

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	[0,0,0,1,0,0]
2	Tool Wear Failure	[0,0,0,0,0,1]
3	No Failure	[0,1,0,0,0,0]
4	Overstrain Failure	[0.008293461054563522,0,0.9917065620422364,0,0,-2.309680002809955e-8]
5		
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Download JSON file

CONCLUSION

- The predictive maintenance model accurately predicts various machine failures using sensor and operational data. Deploying this machine learning solution on IBM Cloud enables real-time maintenance alerts, reducing downtime and costs. Overall, the project meets its goal of making industrial operations smarter and more reliable.

FUTURE SCOPE

- Real-Time Sensor Integration: Connect the system directly to real industrial sensor streams for continuous, real-time failure monitoring and alerts.
- Deployment at Edge Devices: Move models closer to machinery for low-latency local prediction, supporting fast decisions even with slow or unreliable internet.
- Condition-Based and Predictive Scheduling: Integrate maintenance schedules that automatically adjust based on predicted risk, optimizing service times and minimizing downtime.

REFERENCES

- Kaggle Dataset: Shivamb, "Predictive Maintenance of Industrial Machinery."
- IBM Documentation: "What is Predictive Maintenance?", "Deploying ML Models with IBM Watson ML".
- Breiman, L., "Random Forests." Machine Learning, 2001.
- Pedregosa, F. et al., "Scikit-learn: Machine Learning in Python." JMLR, 2011.
- Susto, G.A. et al., "Machine Learning for Predictive Maintenance: A Multiple Classifier Approach." IEEE Trans. Ind. Informatics, 2015.

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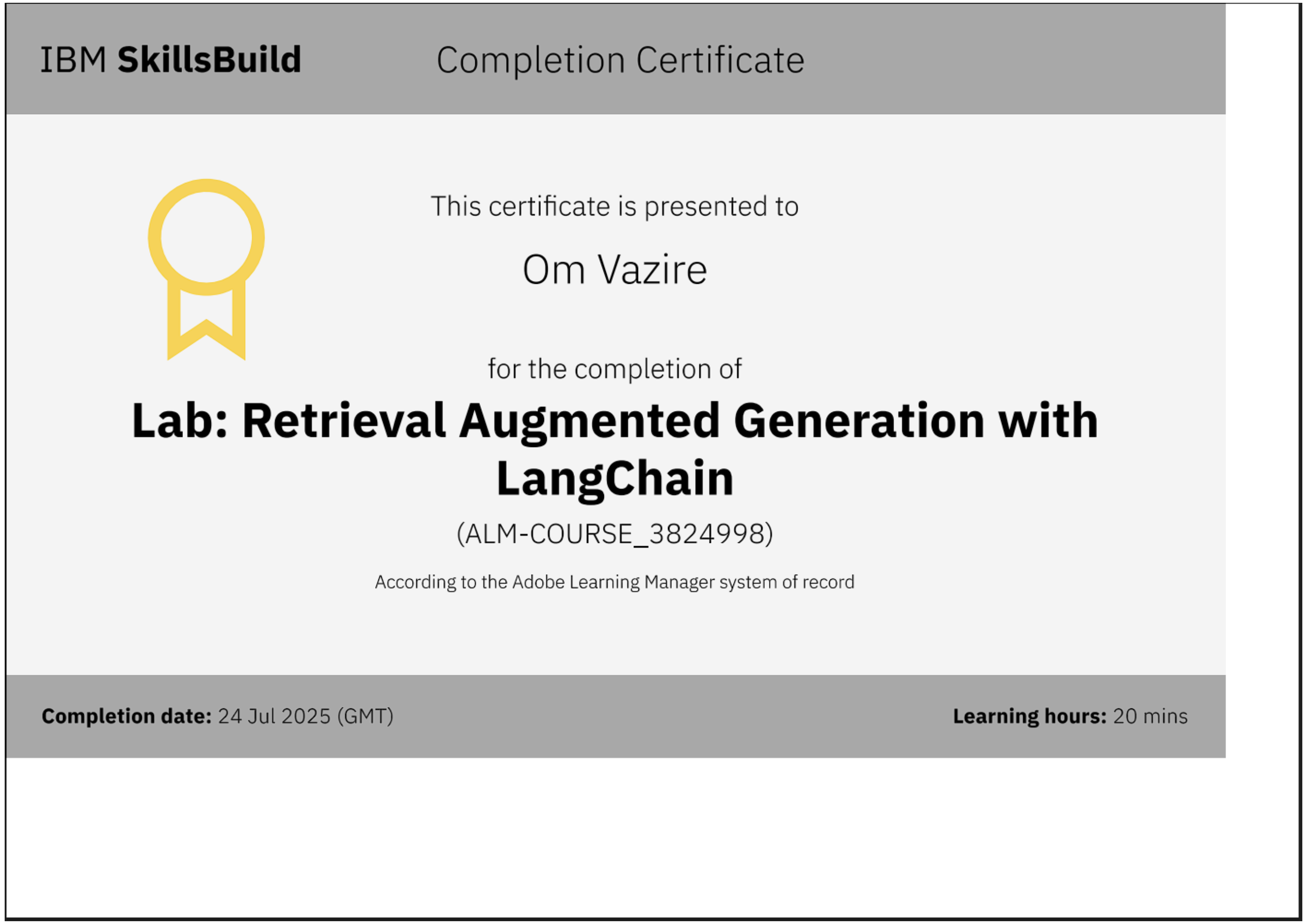

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