CAPSTONE PROJECT

MACHINE FAULT DETECTOR

Presented By:

1. P.SURYA PRAKASH-N.B.K.R.Institute of Science and Technology-ECE

edunet
foundation

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 aims to address the challenge of predicting machine faults before failure occurs in an industrial environment. This involves leveraging machine learning and sensor data analytics to enable proactive maintenance and reduce operational downtime. The solution consists of the following components:

- **Data Collection**:

  Gather historical data from industrial machines, including temperature, torque, rotational speed, tool wear, and machine type.

- **Data Preprocessing**:

  Clean and preprocess data to handle missing values, normalize numeric features, and encode categorical ones.

- **Machine Learning Algorithm**: Use a classification algorithm such as Random Forest or XG Boost to predict fault categories like tool wear failure, heat dissipation, or power failure.
- **Model Deployment**: Deploy the model on IBM Watson Machine Learning. Accept CSV inputs and return predictions along with class-wise probabilities.
- **Visualization**: Provide predictions in table view and multiclass classification chart (pie + bar) for better interpretation.
- **Evaluation**: Assess model accuracy using confusion matrix, precision, recall, and F1-score. Tune model for optimal performance.
- **Result**.

edunet
foundation

SYSTEM APPROACH

SYSTEM APPROACH – Machine Fault Predictor

System requirements:

- IBM Cloud Lite account (free tier)
- IBM Watson Studio with Auto AI enabled
- Web browser with stable internet connection
- Dataset in CSV format for training and testing
- Deployment space in IBM Cloud for model hosting

Libraries required to build the model:

- No coding libraries needed Auto AI handles preprocessing, feature engineering, model selection, and evaluation automatically
- IBM Watson Machine Learning used for deployment and prediction
- Optional: IBM Cloud Object Storage (for storing datasets and assets)

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**

Auto AI automatically selected the best classification algorithm based on model evaluation metrics. In our case, the chosen algorithm was a Random Forest Classifier, which performed best in predicting failure types.

- **Data Input:**

Sensor data such as:

Air temperature

Process temperature

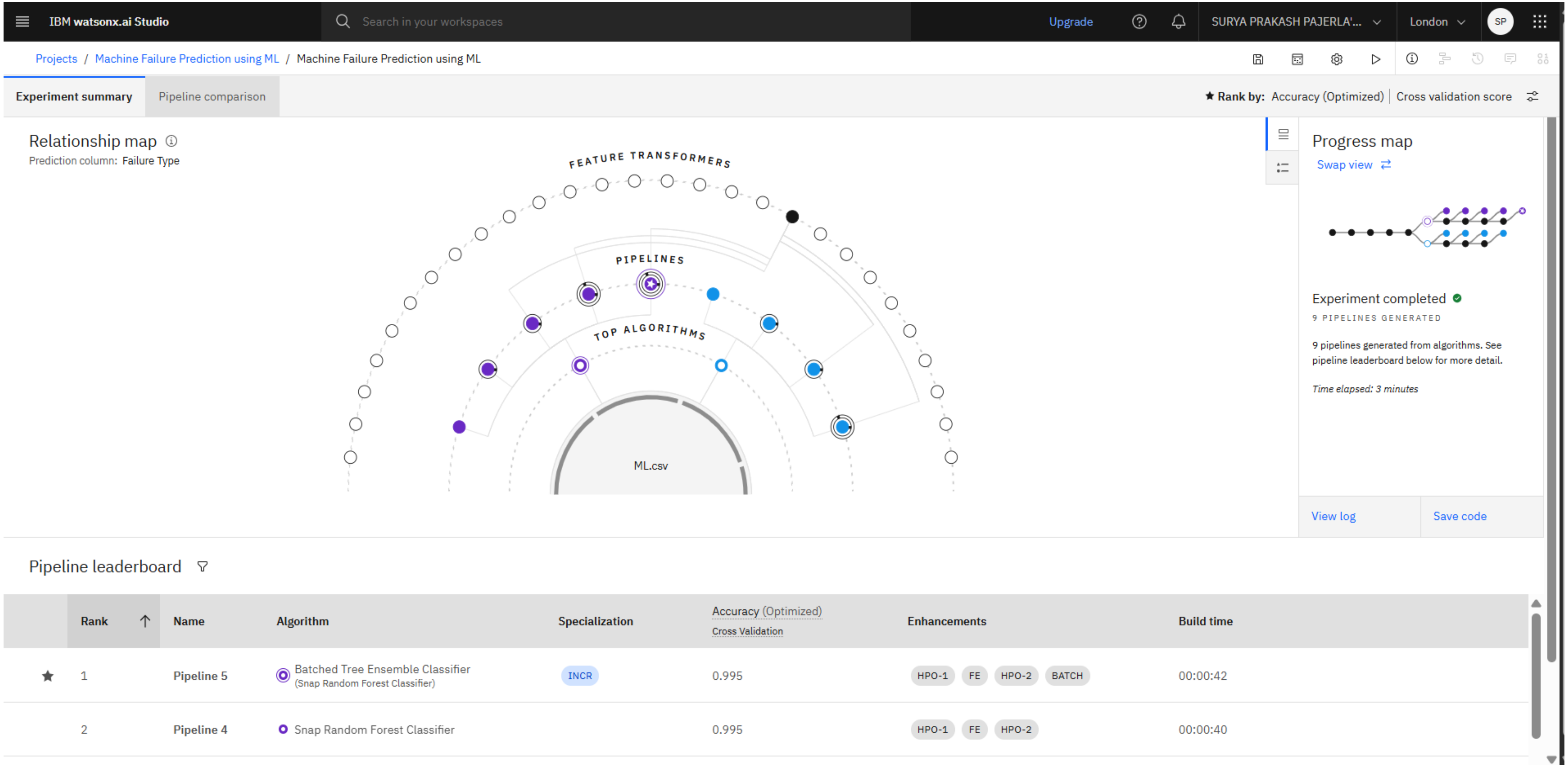
Rotational speed

Torque

Tool wear

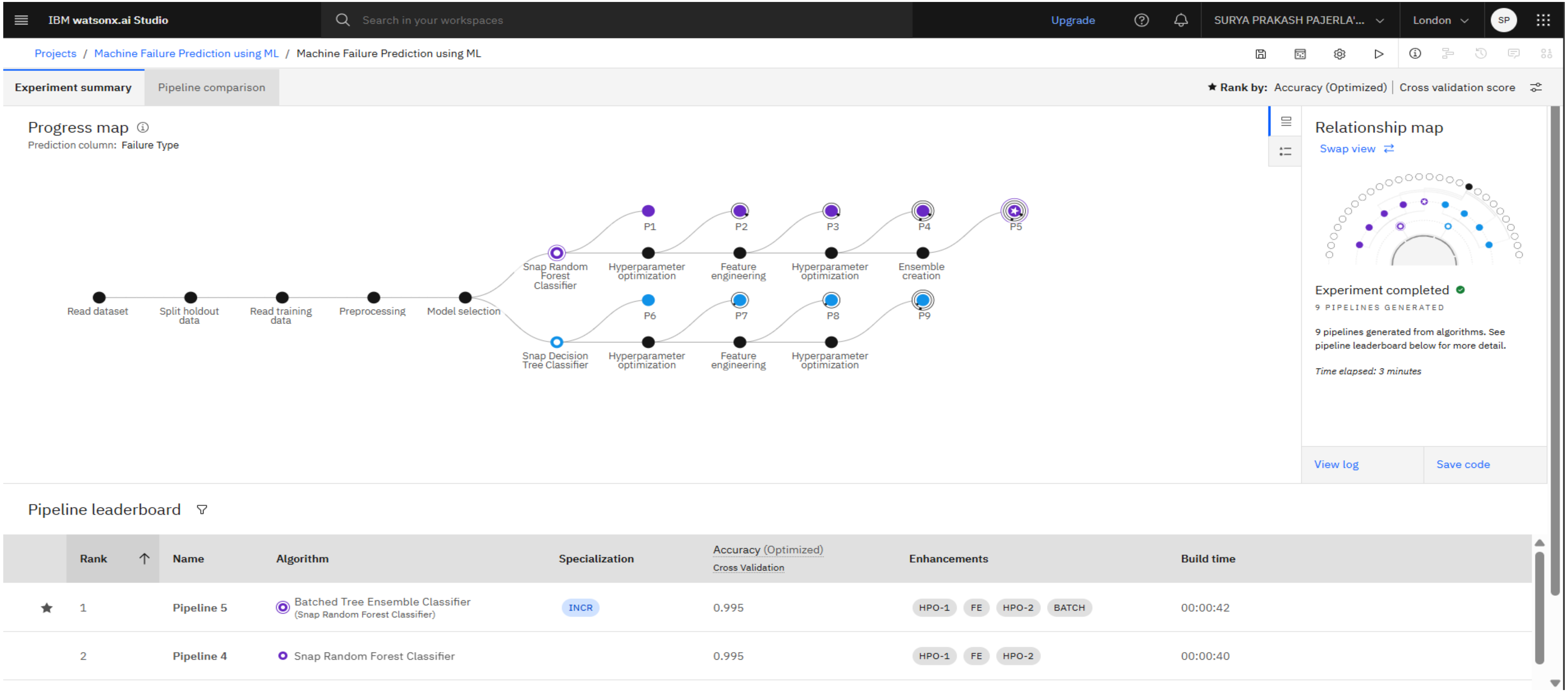
- Machine type were used as input features to predict different machine failures (e.g., tool wear, heat dissipation, power failure).
- Training Process :Auto AI split the dataset into training and validation sets.
- Feature scaling, encoding, and hyperparameter optimization were done automatically. The best pipeline was selected based on accuracy and F1-score.
- Prediction Process: The deployed model accepts test data in CSV format.
- Predictions are shown as class labels (failure type) with probability scores for each class.

RESULT



edunet foundation

RESULT



IBM watsonx.ai Studio
Search in your workspaces
Upgrade
SURYA PRAKASH PAJERLA'...
London
SP
Projects / Machine Failure Prediction using ML / Machine Failure Prediction using ML
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Progress map
Prediction column: Failure Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Random Forest Classifier
Snap Decision Tree Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Ensemble creation
P1
P2
P3
P4
P5
P6
P7
P8
P9
Relationship map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 3 minutes
View log
Save code
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
00:00:42
2
Pipeline 4
Snap Random Forest Classifier
0.995
HPO-1
FE
HPO-2
00:00:40

RESULT

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | SURYA PRAKASH PAJERLA... | London | SP

Deployment spaces / Machine failure deployment / P5 - Snap Random Forest Classifier: Machine Failure Prediction using ML /

Machine failure prediction

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 ×

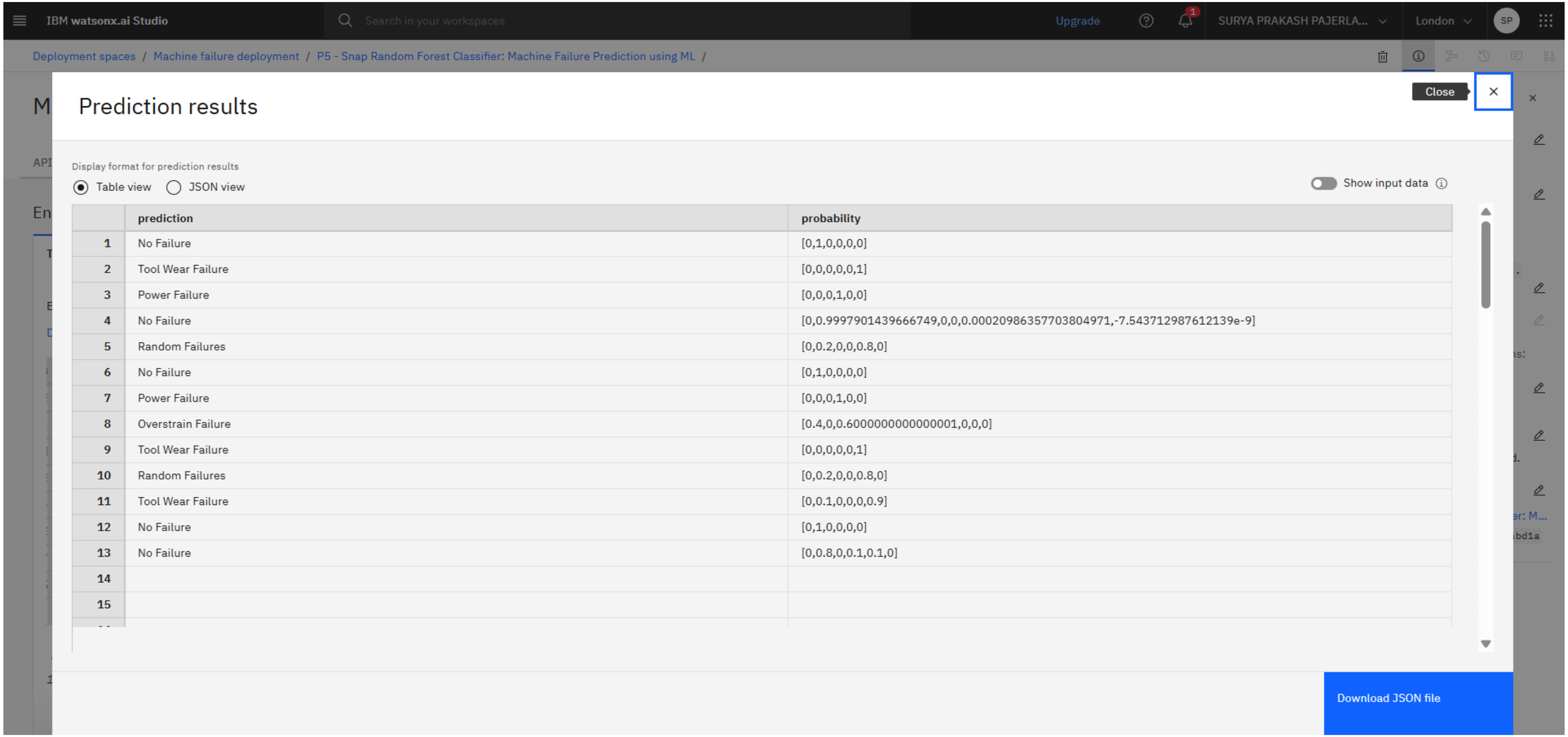
	UDI (double)	Product ID (other)	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)	Tool wear [min] (double)	Target (double)
1	1	M14860	M	298.1	308.6	1551	42.8	0	0
2	2	L47257	L	298.8	308.9	1455	41.3	208	1
3	3	L47230	L	298.9	309.1	2861	4.6	143	1
4	4	L47340	L	298.4	308.2	1471	47	214	0
5	5	L48482	L	298.6	309.8	1505	45.7	144	0
6	6	L48481L	L	298.7	309.9	1483	32.8	142	0
7	7	M16184	M	298.8	310.1	1243	74.5	194	1
8	8	L48514	L	299	310.4	1365	49.1	226	1
9	9	L48689	L	298	308.5	1429	37.7	220	1
10	10	H31162	H	298.4	307.7	1626	31.1	166	0

10 rows, 9 columns

Predict

edunet foundation

RESULT



	prediction	probability
1	No Failure	[0,1,0,0,0,0]
2	Tool Wear Failure	[0,0,0,0,0,1]
3	Power Failure	[0,0,0,1,0,0]
4	No Failure	[0,0.9997901439666749,0,0,0.00020986357703804971,-7.543712987612139e-9]
5	Random Failures	[0,0.2,0,0,0.8,0]
6	No Failure	[0,1,0,0,0,0]
7	Power Failure	[0,0,0,1,0,0]
8	Overstrain Failure	[0.4,0,0.6000000000000001,0,0,0]
9	Tool Wear Failure	[0,0,0,0,0,1]
10	Random Failures	[0,0.2,0,0,0.8,0]
11	Tool Wear Failure	[0,0.1,0,0,0,0.9]
12	No Failure	[0,1,0,0,0,0]
13	No Failure	[0,0.8,0,0.1,0.1,0]
14		
15		

edunet foundation

CONCLUSION

- A machine learning model was successfully developed using IBM AutoAI to predict different types of industrial machinery failures based on sensor data.
- The system effectively classifies failure types such as tool wear, heat dissipation, and power failure, enabling timely and preventive maintenance actions.
- The no-code Auto AI platform simplified model training and deployment, making the solution accessible to non-programmers.
- Deployment on IBM Cloud ensures scalability, real-time access, and ease of integration into industrial workflows.
- The solution helps industries reduce unplanned downtime, extend machine life, and minimize maintenance costs through proactive fault detection.
- Overall, the project demonstrates how AI-powered predictive maintenance can enhance operational efficiency in industrial environments.

FUTURE SCOPE

- Integrate real-time sensor data streaming from IoT-enabled machines to allow continuous fault monitoring
- .Expand the model to predict remaining useful life (RUL) of machine components for better maintenance planning.
- Incorporate additional parameters like vibration or sound analysis to enhance prediction accuracy.
- Enable mobile app or dashboard-based alerts for fault detection and maintenance scheduling.
- Train the model with a larger and more diverse dataset to improve generalization across different machine types.
- Use edge computing for on-device predictions in remote or bandwidth-limited industrial settings.
- Combine predictive maintenance with prescriptive recommendations for optimal repair actions.

REFERENCES

- Predictive Maintenance Dataset from Kaggle
- IBM Watson Studio Documentation
- IBM Watson Machine Learning Documentation
- IBM Auto AI Overview
- Scikit-learn Library Documentation
- Shivam Bansal, Predictive Maintenance Data, Kaggle, 2020.

IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

SURYA PRAKASH PAJERLA

Has successfully satisfied the requirements for:

Getting Started with Artificial Intelligence

Issued on: Jul 16, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/48bcb536-6e8e-41fe-ba39-52a425a205fa

IBM CERTIFICATIONS

Journey to Cloud: Envisioning Your Solution

IBM SkillsBuild

IBM

In recognition of the commitment to achieve professional excellence

SURYA PRAKASH PAJERLA

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 17, 2025

Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/e8a0c694-c398-47ad-8235-ce9b6cd43e37

IBM

edunet foundation

IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

SURYA PRAKASH PAJERLA

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins

THANK YOU