CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:
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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

1. *Data Collection:* Collect sensor data from machines, including temperature, vibration, pressure, and power consumption.

2. *Data Preprocessing:* Clean and preprocess data, handling missing values and normalizing/scale data.

3. *Feature Engineering:* Extract relevant features from sensor data, such as time-domain and frequency-domain features.

4. *Model Training:* Train a classification model using machine learning algorithms, such as Random Forest or Convolutional Neural Networks.

5. *Model Deployment:* Deploy the model in a production-ready environment, integrating with real-time data streams from machines.

6. *Model Monitoring:* Continuously monitor model performance and update as needed.

Benefits:*

1. *Reduced Downtime:* Predict potential failures before they occur, enabling proactive maintenance.

2. *Cost Savings:* Minimize emergency repairs and reduce waste.

3. *Improved Efficiency:* Optimize machine performance and reduce energy consumption.

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SYSTEM APPROACH

Data Collection*: Sensors and IoT devices continuously monitor equipment conditions such as temperature, vibration, pressure, and other relevant parameters.

- *Data Processing & AI Analysis*: Machine learning models analyze collected data to detect anomalies and predict potential failures. AI-powered algorithms identify patterns and trends that can lead to equipment failure.

- *Predictive Alerts*: The system sends alerts to maintenance teams before an issue escalates, allowing for proactive maintenance and minimizing downtime.

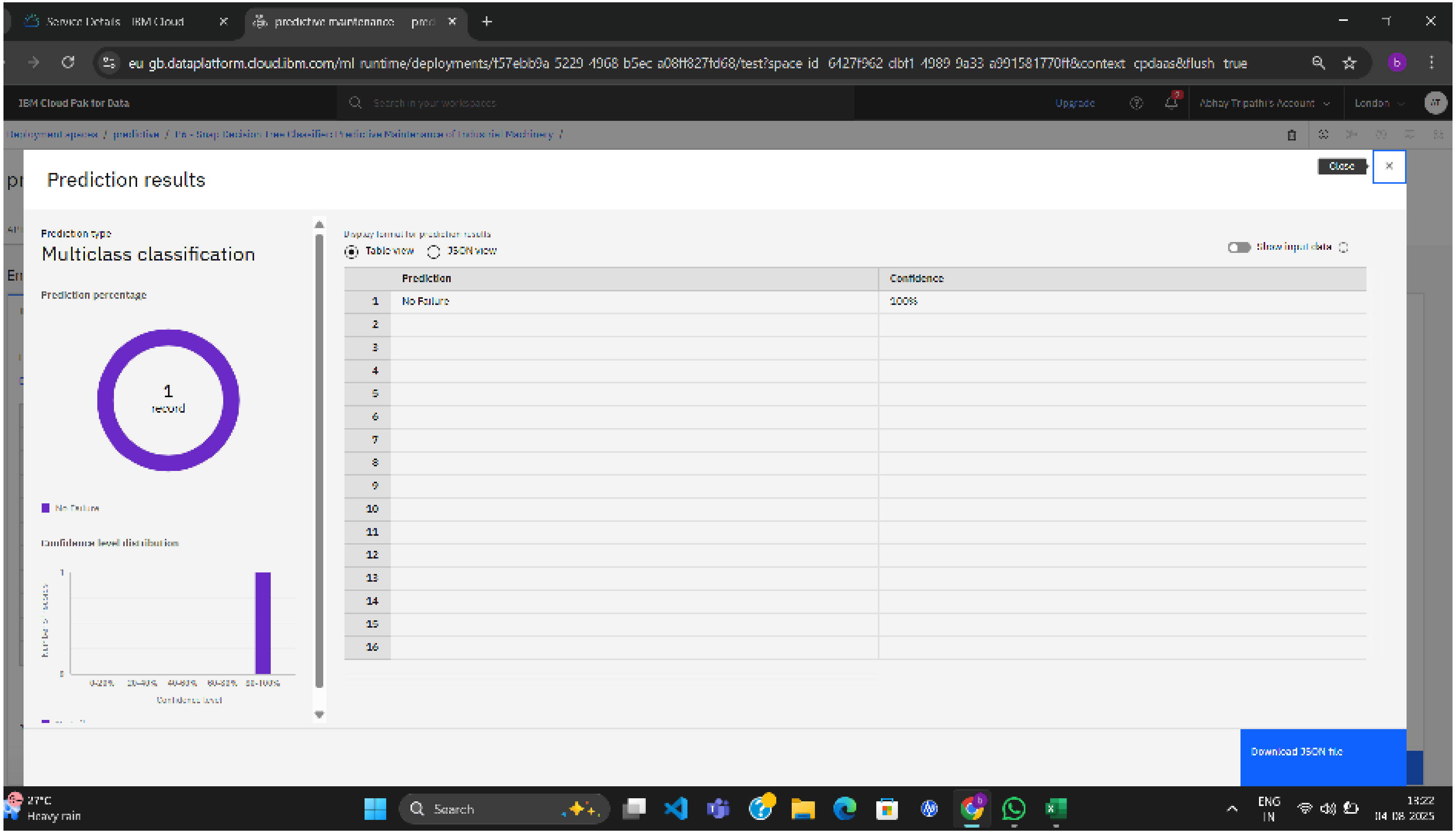
- *Condition-Based Monitoring*: Maintenance is scheduled only when necessary, reducing costs and downtime.

ALGORITHM & DEPLOYMENT

- Algorithm Development
- 1. *Data Collection*: Gather sensor data from industrial machinery, including temperature, vibration, and pressure readings.
- 2. *Data Preprocessing*: Clean and preprocess the data, handling missing values and normalizing/scale data.
- 3. *Feature Engineering*: Extract relevant features from sensor data, such as time-domain and frequency-domain features.
- 4. *Model Training*: Train a machine learning model using algorithms like Random Forest, Support Vector Machine (SVM), or Convolutional Neural Networks (CNN).
- Deployment on IBM Cloud
- 1. *IBM Cloud Pak for Data*: Use IBM Cloud Pak for Data to build and deploy a predictive maintenance scheduling solution.
- 2. *Edge Deployment*: Deploy data reduction algorithms on edge devices using Simulink Coder and MATLAB Production Server.
- 3. *Cloud Deployment*: Deploy machine learning models on IBM Cloud, using cloud-based services like IBM Watson Studio and IBM Cloud Functions.
- 4. *Monitoring and Feedback*: Monitor model performance, update models as needed, and incorporate feedback from users and maintenance personnel.

RESULT

https://github.com/bhargav-abhay/Predictive-Maintenance-of-Industrial
-Machinery


Prediction results
Close
Prediction type
Multiclass classification
Prediction percentage
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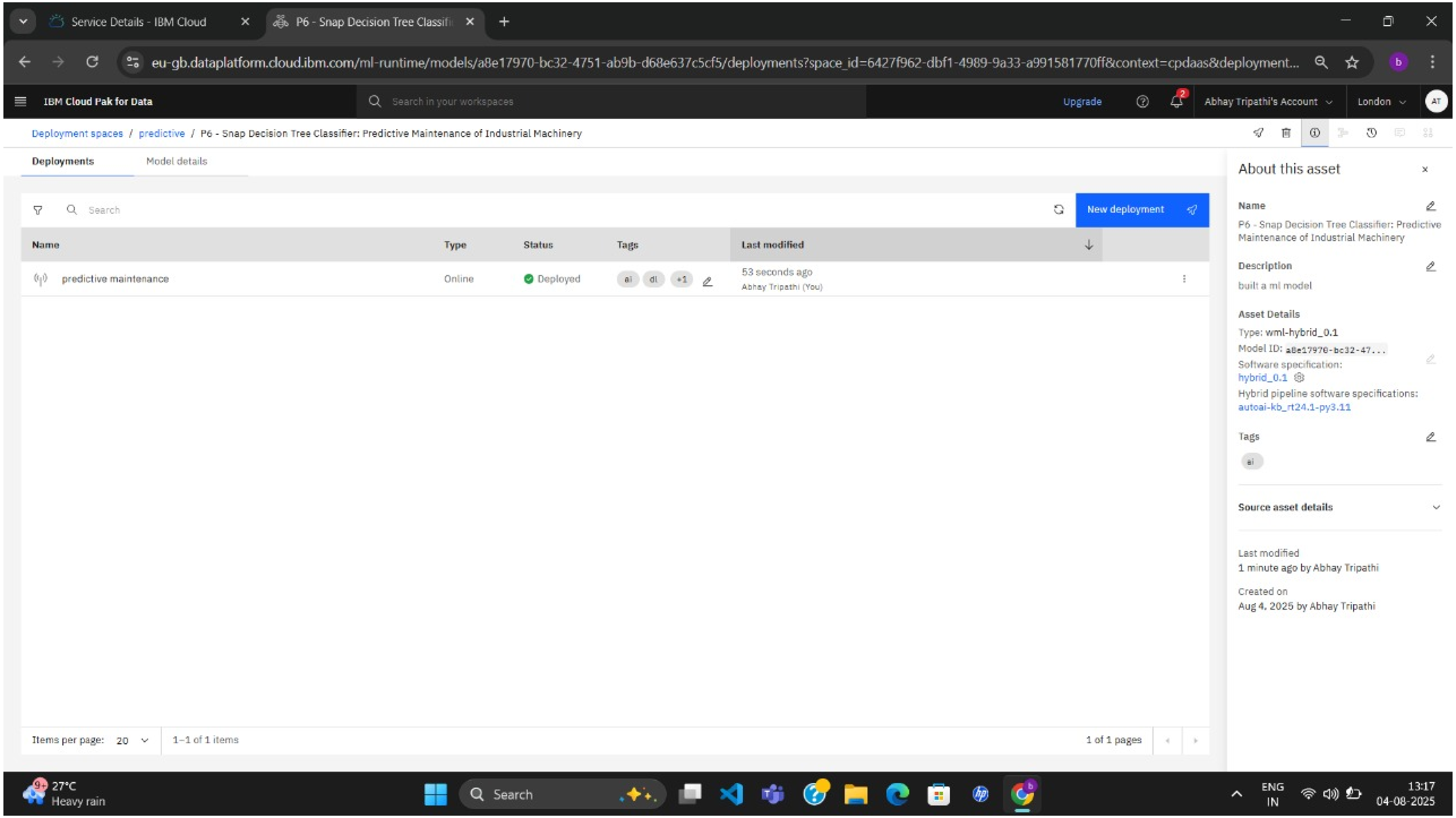
record
No Failure
Confidence level distribution
Confidence level
Table view
JSON view
Show input data
Prediction
Confidence
No Failure
100%
Download JSON file
27°C
Heavy rain
Search
ENG
IN
13:22


Service Details - IBM Cloud
P6 - Snap Decision Tree Classifi
eu-gb.dataplatform.cloud.ibm.com/ml-runtime/models/a8e17970-bc32-4751-ab9b-d68e637c5cf5/deployments?space_id=6427f962-dbf1-4989-9a33-a991581770ff&context=cpdaas&deployment...
IBM Cloud Pak for Data
Search in your workspaces
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Deployment spaces / predictive / P6 - Snap Decision Tree Classifier: Predictive Maintenance of Industrial Machinery
Deployments
Model details
Search
New deployment
Name
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Status
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Online
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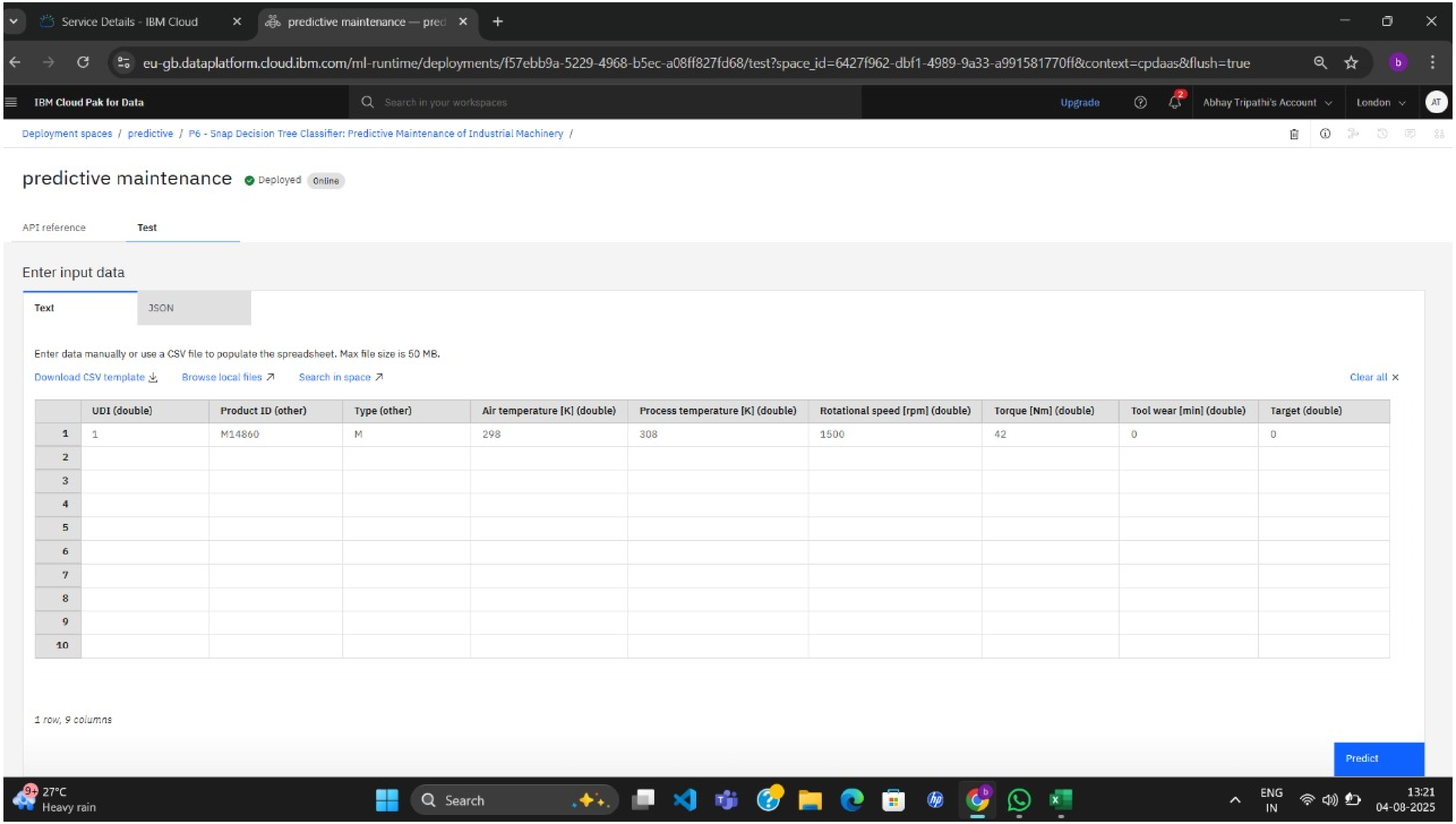
53 seconds ago
Abhay Tripathi (You)
Items per page: 20
1–1 of 1 items
1 of 1 pages
About this asset
Name
P6 - Snap Decision Tree Classifier: Predictive Maintenance of Industrial Machinery
Description
built a ml model
Asset Details
Type: wml-hybrid_0.1
Model ID: a8e17970-bc32-47...
Software specification:
hybrid_0.1
Hybrid pipeline software specifications:
autoai-kb_rt24.1-py3.11
Tags
ai
Source asset details
Last modified
1 minute ago by Abhay Tripathi
Created on
Aug 4, 2025 by Abhay Tripathi
27°C
Heavy rain
Search
ENG
IN
13:17
04-08-2025



Service Details - IBM Cloud
predictive maintenance — pred
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IBM Cloud Pak for Data
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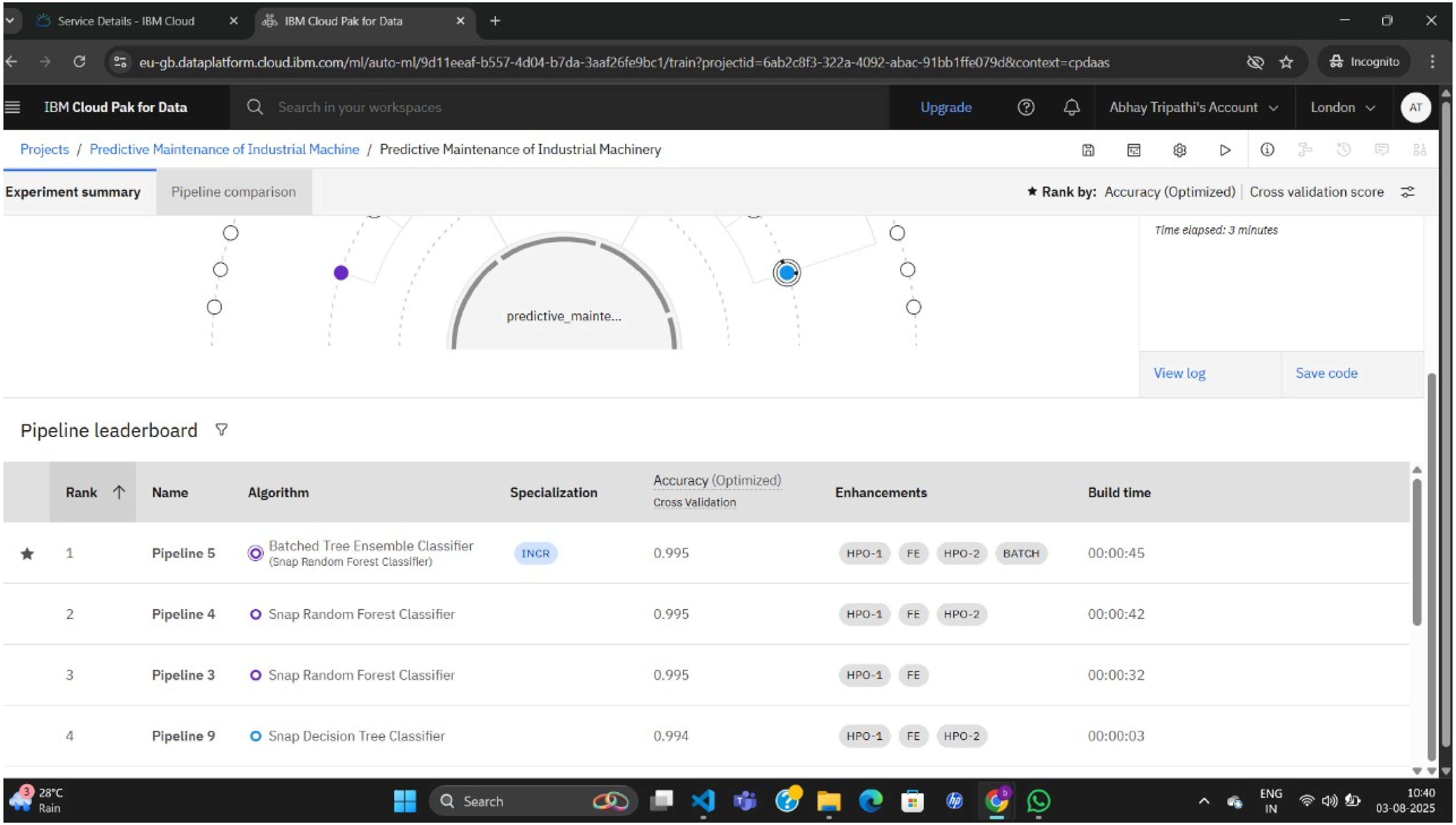
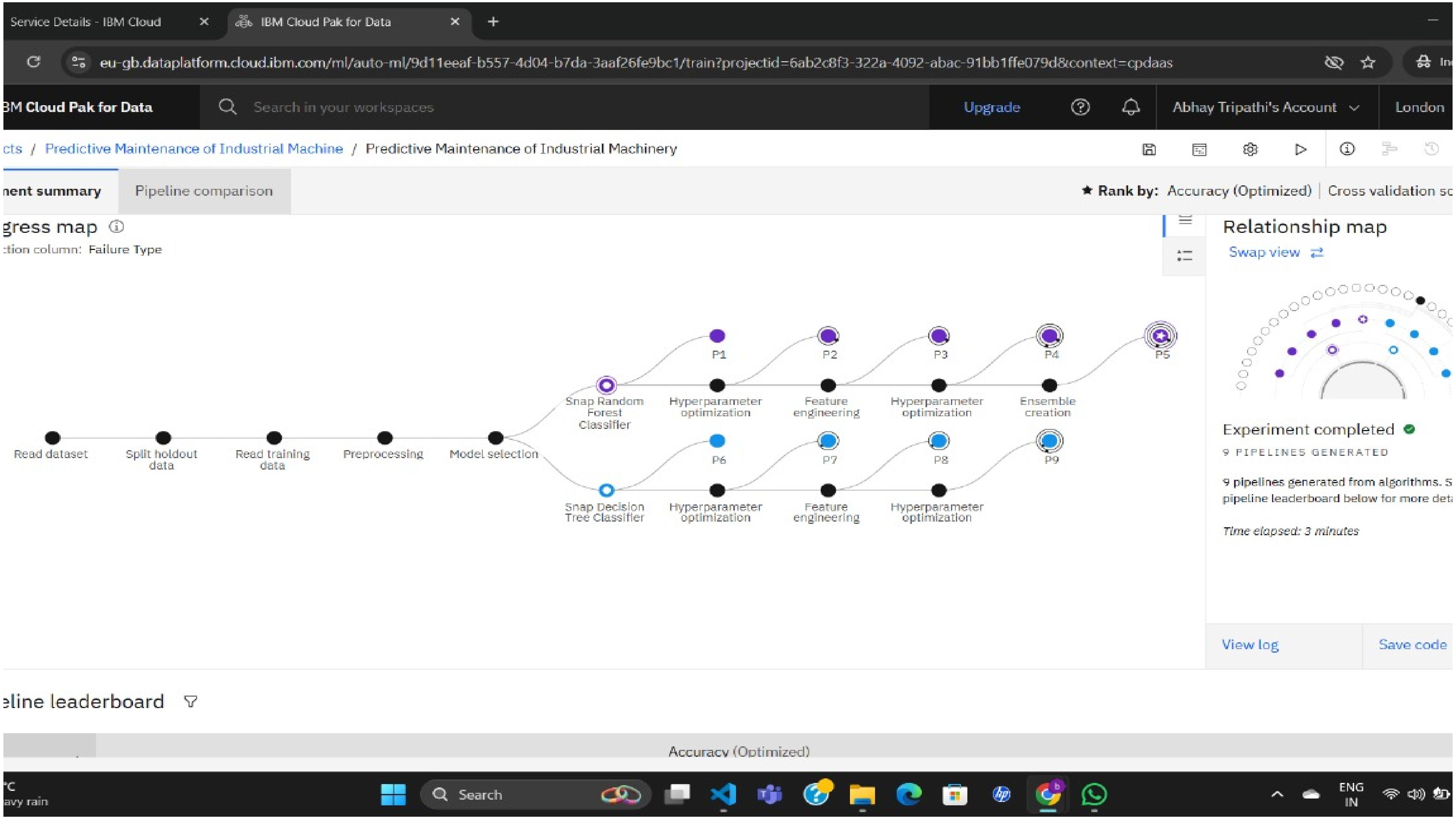
Deployment spaces / predictive / P6 - Snap Decision Tree Classifier: Predictive Maintenance of Industrial Machinery /
predictive maintenance
Deployed
Online
API reference
Test
Enter input data
Text
JSON
Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.
Download 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	308	1500	42	0	0
2									
3									
4									
5									
6									
7									
8									
9									
10									

1 row, 9 columns
Predict
27°C
Heavy rain
Search
ENG
IN
13:21
04-08-2025



	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	00:00:45
	2	Pipeline 4	Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:00:42
	3	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:32
	4	Pipeline 9	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:03


Service Details - IBM Cloud
IBM Cloud Pak for Data
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BM Cloud Pak for Data
Search in your workspaces
Upgrade
Abhay Tripathi's Account
London
cts / Predictive Maintenance of Industrial Machine / Predictive Maintenance of Industrial Machinery
nent summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation sc
gress map
ction column: Failure Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Random Forest Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Ensemble creation
P1
P2
P3
P4
P5
Snap Decision Tree Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
P6
P7
P8
P9
Relationship map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. S
pipeline leaderboard below for more det
Time elapsed: 3 minutes
View log
Save code
eline leaderboard
Accuracy (Optimized)
Search
ENG
IN

Projects / Predictive Maintenance of Industrial Machine / P6 - Snap Decision Tree Classifier: Predictive...

AutoAI | Part of IBM Watson® Studio

Pipeline notebook

Pipeline 6 Notebook - AutoAI Notebook v2.1.7

Consider these tips for working with an auto-generated notebook:

- Notebook code generated using AutoAI will execute successfully. If you modify the notebook, we cannot guarantee it will run successfully.
- This pipeline is optimized for the original data set. The pipeline might fail or produce sub-optimal results if used with different data. If you want to use a different data set, consider retraining the AutoAI experiment to generate a new pipeline. For more information, see Cloud Platform.
- Before modifying the pipeline or trying to re-fit the pipeline, consider that the code converts dataframes to numpy arrays before fitting the pipeline (a current restriction of the preprocessor pipeline).

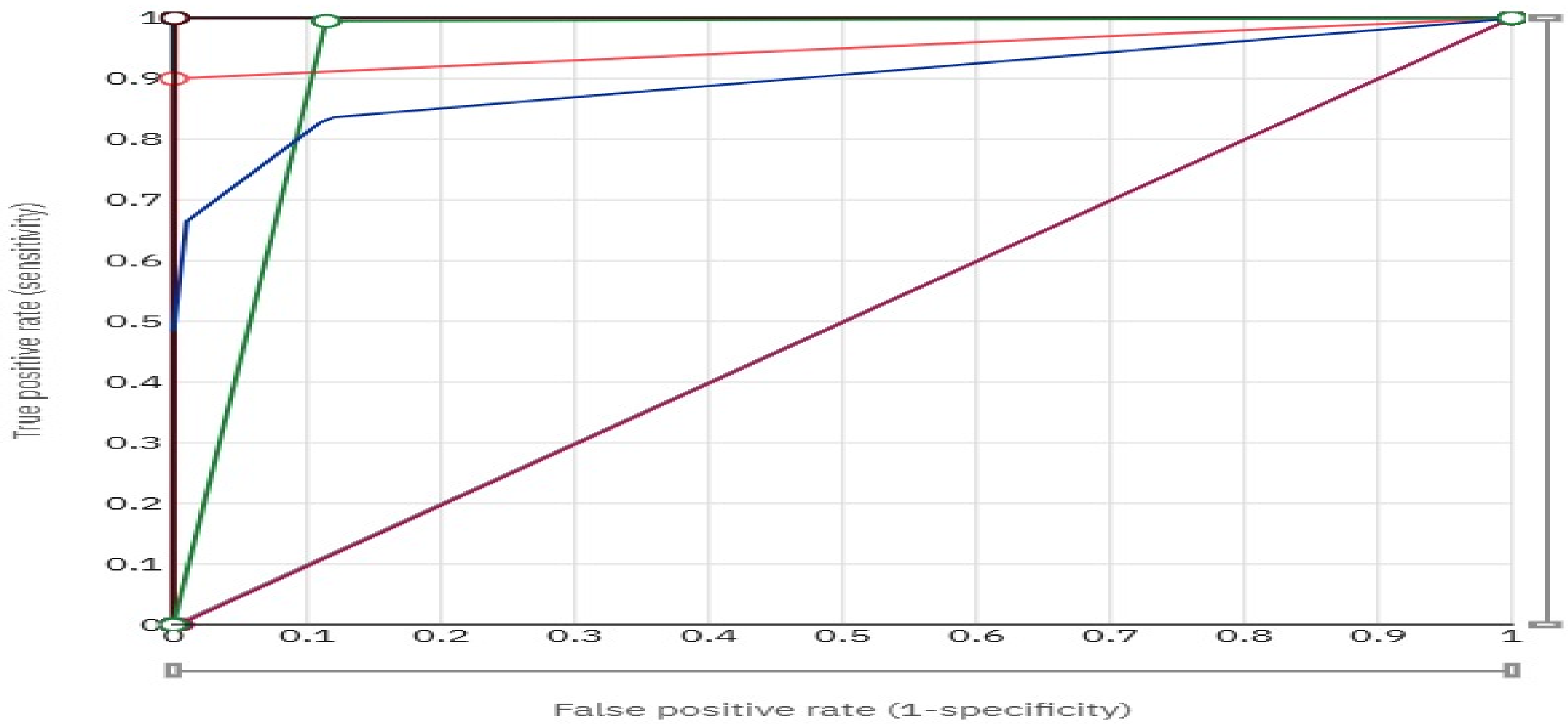
Notebook content

This notebook contains a Scikit-learn representation of AutoAI pipeline. This notebook introduces commands for retrieving data, training the model, and testing the model.

Some familiarity with Python is helpful. This notebook uses Python 3.11 and scikit-learn 1.3.

Notebook goals

- Scikit-learn pipeline definition
- Pipeline training
- Pipeline evaluation


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
True positive rate (sensitivity)
False positive rate (1-specificity)

CONCLUSION

Predictive maintenance optimizes equipment performance, reduces downtime and costs, and improves efficiency through machine learning algorithms and scalable IBM Cloud deployment, enabling industries to stay competitive and achieve operational excellence.

FUTURE SCOPE

The future scope of predictive maintenance includes integrating AI, IoT, and edge computing to further enhance predictive accuracy and enable real-time decision-making, driving increased efficiency, reduced costs, and improved asset reliability across industries, while also enabling proactive maintenance, minimizing downtime, and optimizing resource allocation.

REFERENCES

- 1. *IBM*: IBM Cloud Pak for Data, IBM Watson Studio, IBM Maximo
- 2. *Research Papers*:
  - "Predictive Maintenance using Machine Learning" by IEEE
  - "A Survey on Predictive Maintenance for Industrial Equipment" by Elsevier
- 3. *Industry Reports*:
  - "Predictive Maintenance Market Research Report" by MarketsandMarkets
  - "Industrial IoT and Predictive Maintenance" by McKinsey
- 4. *Online Resources*:
  - Predictive maintenance articles on IBM.com
  - Predictive maintenance blogs on LinkedIn

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Completion Certificate

This certificate is presented to

Abhay Tripathi

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 19 Jul 2025 (GMT)

Learning hours: 20 mins

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THANK YOU