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**
- **IBM Certifications**

PROBLEM STATEMENT

Industrial machines often fail unexpectedly, causing **unplanned downtime** and **high maintenance costs**. Traditional maintenance approaches:

- **Reactive maintenance**: Fix after failure → leads to production loss.
- **Scheduled maintenance**: Fixed intervals → may waste resources.
  The challenge: **Predict failures before they occur** using **real-time operational data**, enabling **proactive maintenance**.

PROPOSED SOLUTION

- Build a **predictive maintenance system** using **IBM Watsonx.ai Studio** and **IBM Cloud services**.
- Steps:
  - **Upload Kaggle Dataset** to IBM Cloud Object Storage.
  - Use **Watson Studio AutoAI** or **Watsonx.ai** for model creation (classification).
  - Train model to classify failure types:
    - Tool Wear
    - Heat Dissipation Failure
    - Power Failure
    - Overstrain
    - Random Failures
  - Deploy model using **IBM Watson Machine Learning** for real-time API access.
- Goal: Enable early alerts for maintenance to **reduce downtime and costs**.

SYSTEM DEVELOPMENT APPROACH (IBM TECHNOLOGIES USED)

IBM Watsonx.ai Studio → For model building using AutoAI (no manual coding).

IBM Cloud Object Storage → To store the dataset.

IBM Watson Machine Learning → For model deployment as a REST API.

Optional: IBM Cloud Functions → For automation and integration with applications.

Why IBM Cloud?

- Low-code/no-code ML pipeline
- Easy deployment
- Scalable and reliable cloud environment

ALGORITHM & DEPLOYMENT

Algorithm Used:

- IBM AutoAI selected **Random Forest Classifier** for best performance.
- Reason: Handles multi-class classification efficiently and provides high accuracy.

Input Data:

- Features: Air Temperature, Process Temperature, Rotational Speed, Torque, Tool Wear.
- Target: Failure type (Tool Wear, Heat Dissipation, Power Failure, Overstrain, Random Failure).

Training Process:

- AutoAI automatically:
    - Preprocesses data (handles missing values, normalisation).
    - Splits into training and testing sets.
    - Trains multiple models and picks the best one (Random Forest).

Deployment:

- Model deployed on **IBM Watson Machine Learning** as an API endpoint.
- Predictions can be accessed in real-time via IBM Cloud.

RESULT

AutoAI selected **Random Forest Classifier** with **high accuracy**

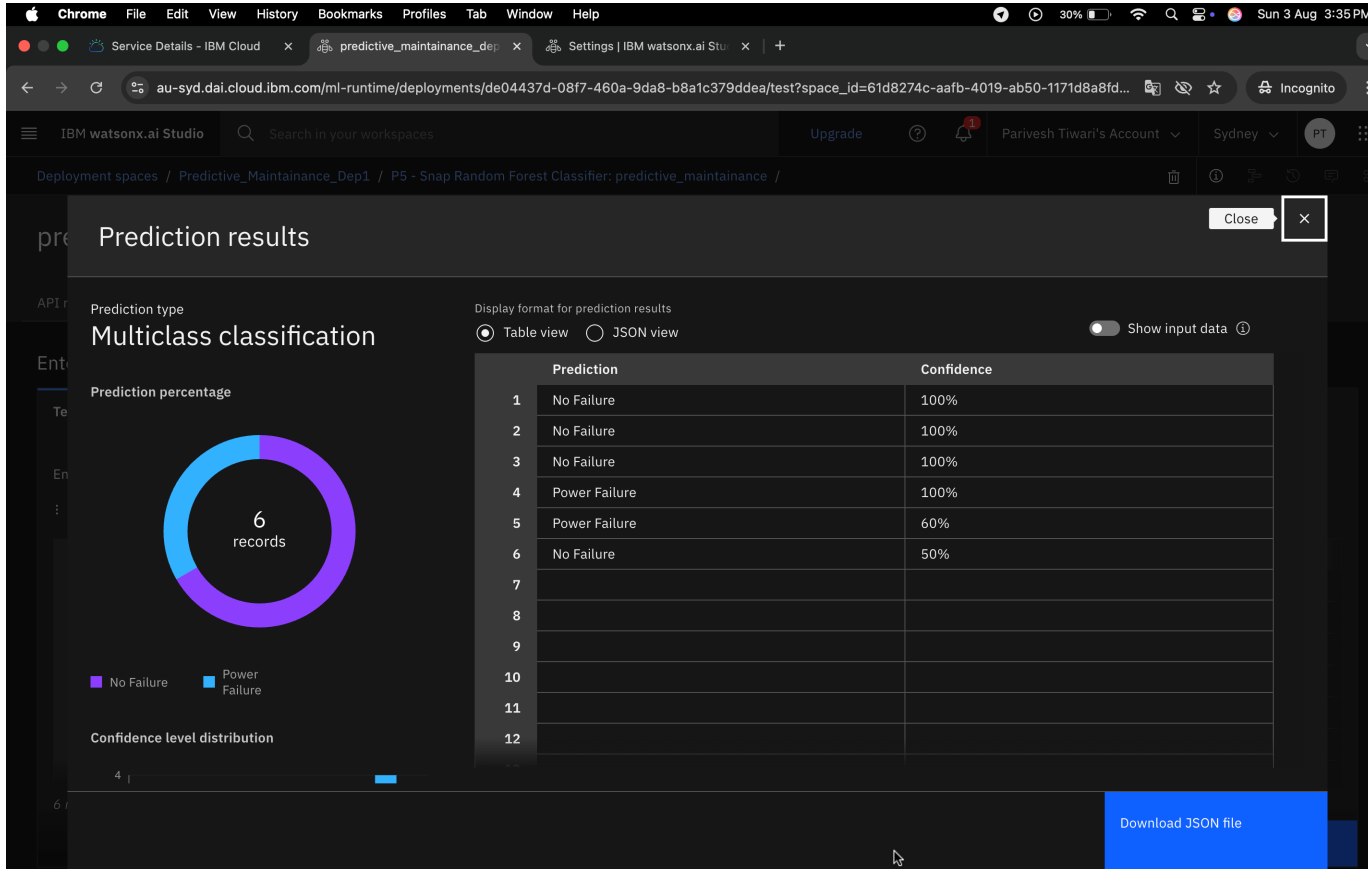
(e.g., 95% on test data).

Dashboard in Watson Studio shows:

- Confusion Matrix
- Accuracy, Precision, Recall

Deployed successfully on IBM Cloud for real-time prediction.

Output: Given sensor readings → Predicts failure type (e.g., “Tool Wear Failure”).



CONCLUSION

- Developed a **Predictive Maintenance System** using **IBM Watsonx.ai Studio** and **IBM Cloud services**.
- Model predicts failure type before breakdown, enabling **proactive maintenance**.
- Benefits:
  - Reduces **unexpected downtime**
  - Lowers **maintenance cost**
- **Challenges:**
  - Handling imbalanced classes in AutoAI.
  - Real-time IoT data integration not implemented yet.
- IBM Cloud simplified the entire ML lifecycle from **data upload → model training → deployment**.

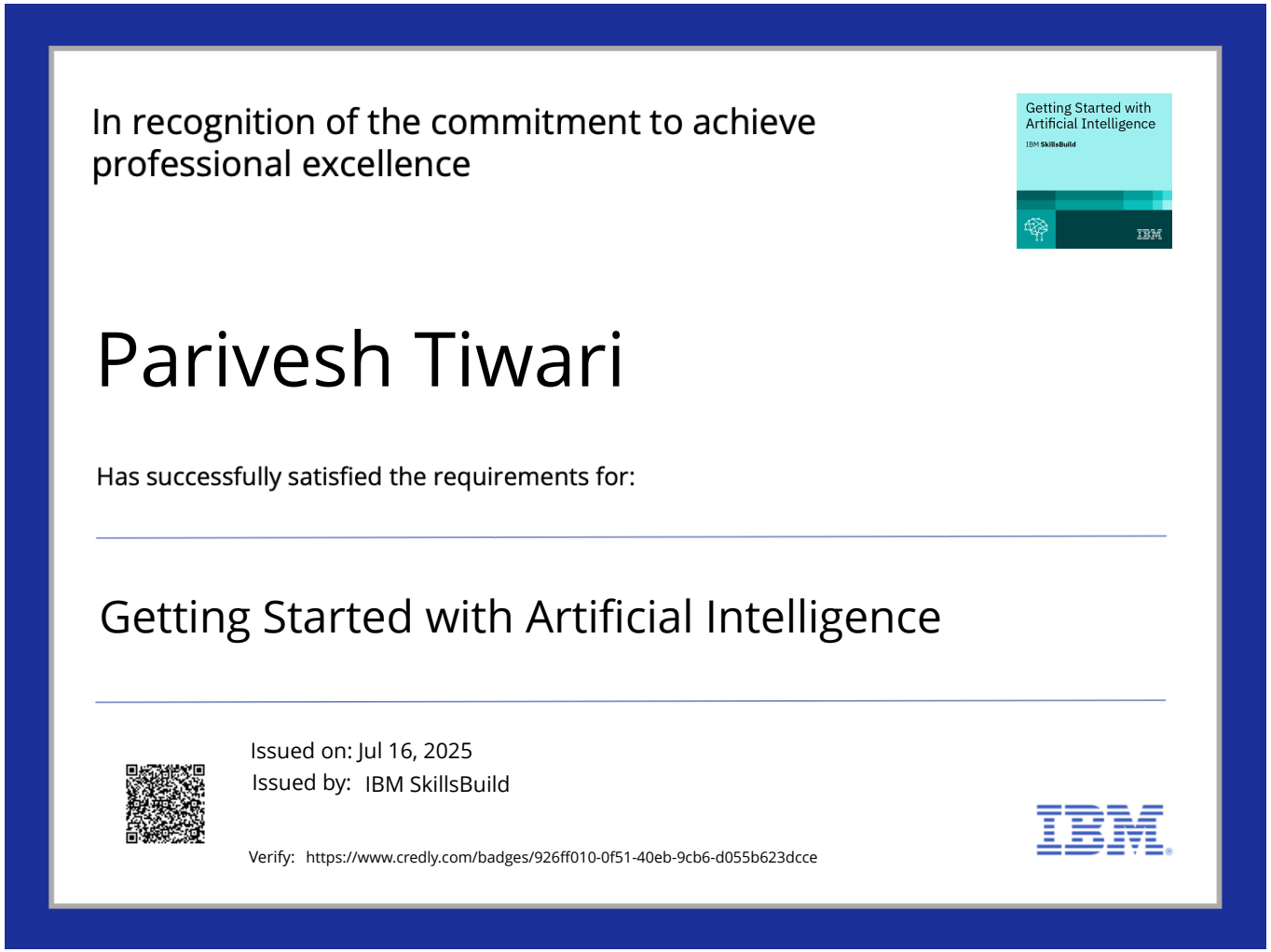
FUTURE SCOPE

- **Integrate IoT sensors** for real-time data streaming.
- Use **deep learning** models for more complex failure prediction.
- Predict **Remaining Useful Life (RUL)** of machinery components.
- Build a **dashboard for factory operators** using IBM Cloud Functions and Node-RED.
- Deploy solution on **edge devices** for real-time on-site predictions.

REFERENCES

- IBM Watsonx.ai & AutoAI Documentation – https://cloud.ibm.com/docs/watsonx-ai
- IBM Watson Machine Learning – https://www.ibm.com/cloud/machine-learning
- Kaggle Dataset – https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification

IBM CERTIFICATIONS



In recognition of the commitment to achieve professional excellence

Getting Started with Artificial Intelligence
IBM SkillsBuild

Parivesh Tiwari

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/926ff010-0f51-40eb-9cb6-d055b623dcce

IBM

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Has successfully satisfied the requirements for:

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IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Parivesh Tiwari

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

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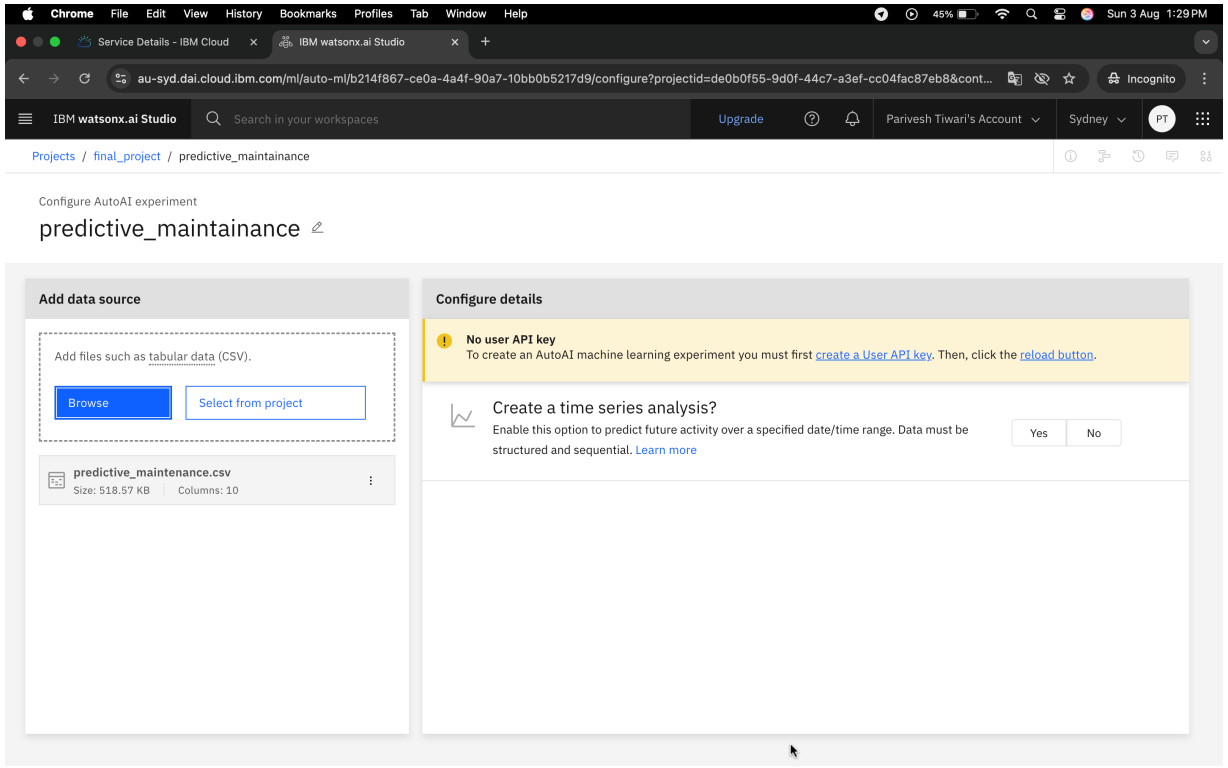
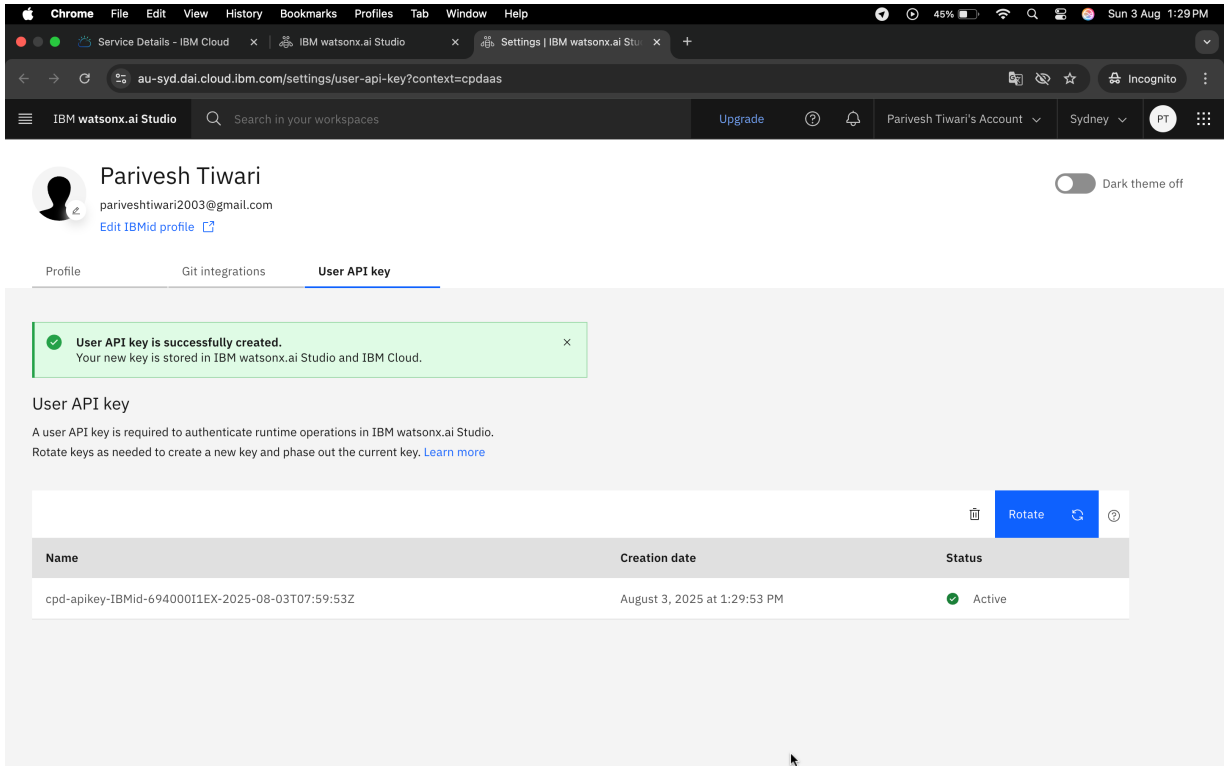
PROJECT SNAPSHOTS





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Chrome File Edit View History Bookmarks Profiles Tab Window Help 44% Sun 3 Aug 1:35 PM

Service Details - IBM Cloud | predictive_maintainance — fi | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml/auto-ml/b214f867-ce0a-4a4f-90a7-10bb0b5217d9/configure?projectid=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&cont... Incognito

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / predictive_maintainance

Configure AutoAI experiment

predictive_maintainance

Autosaved: 13:34:15

Add data source

Add files such as tabular data (CSV).

Browse | Select from project

predictive_maintenance.csv
Size: 518.57 KB | Columns: 10

Configure details

Create a time series analysis?

Enable this option to predict future activity over a specified date/time range. Data must be structured and sequential. Learn more

Yes | No

What do you want to predict?

Prediction column

Failure Type

Prediction column: Failure Type

CUH remaining: 20 CUH

PREDICTION TYPE
Multiclass Classification

OPTIMIZED FOR
Accuracy & run time

Experiment settings | Run experiment

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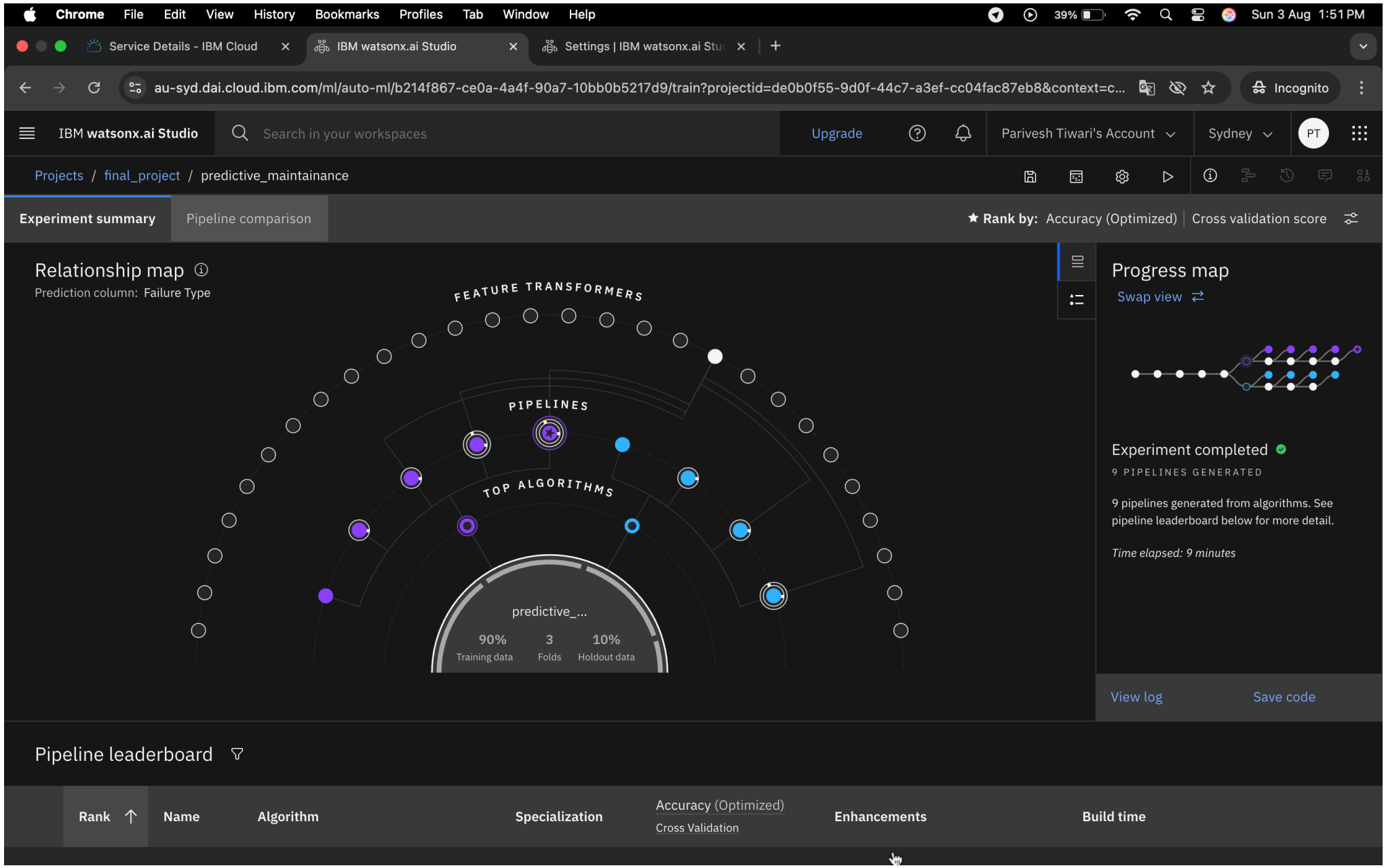

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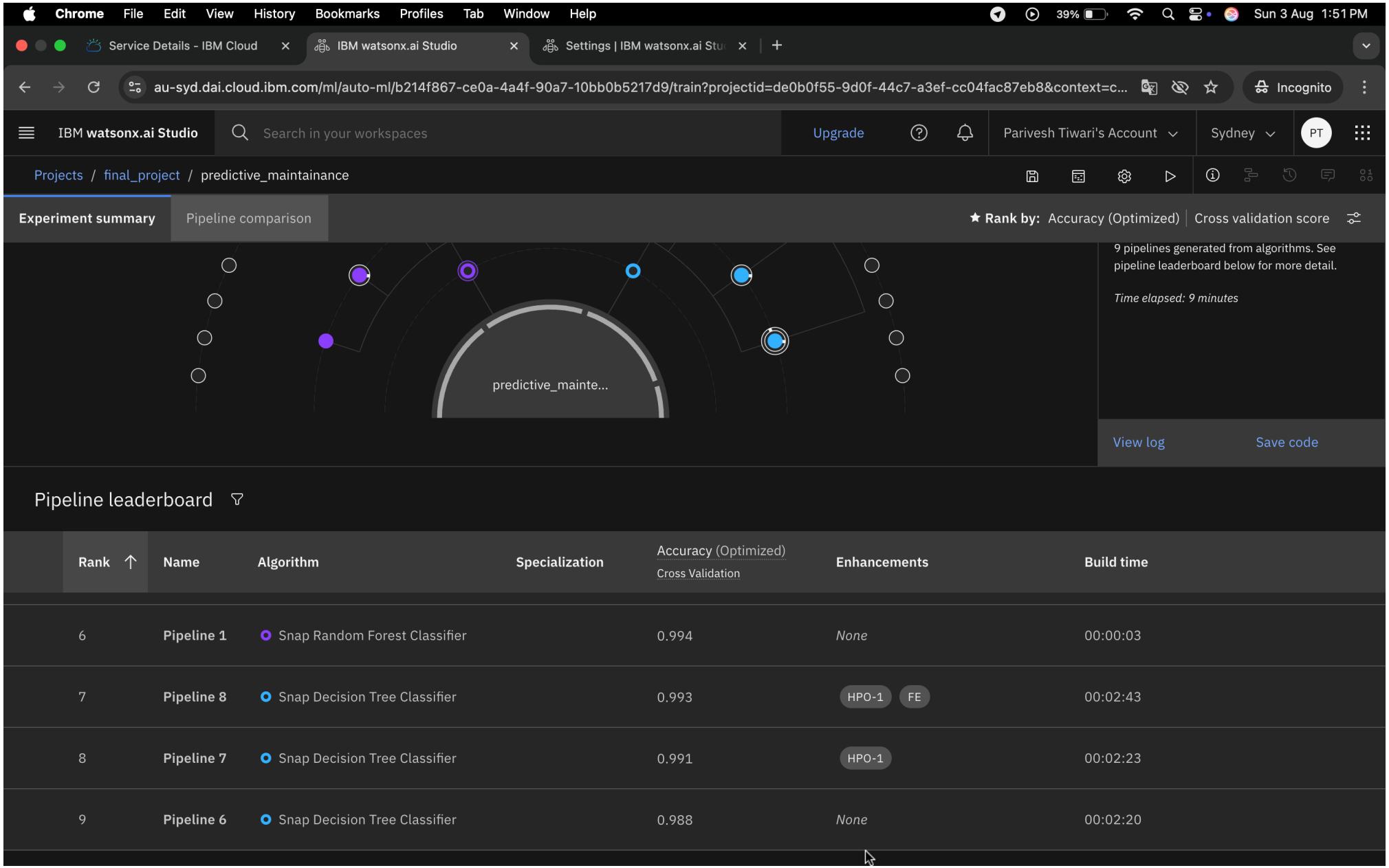

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Service Details - IBM Cloud | IBM watsonx.ai Studio | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml/auto-ml/b214f867-ce0a-4a4f-90a7-10bb0b5217d9/train?projectid=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&context=c...

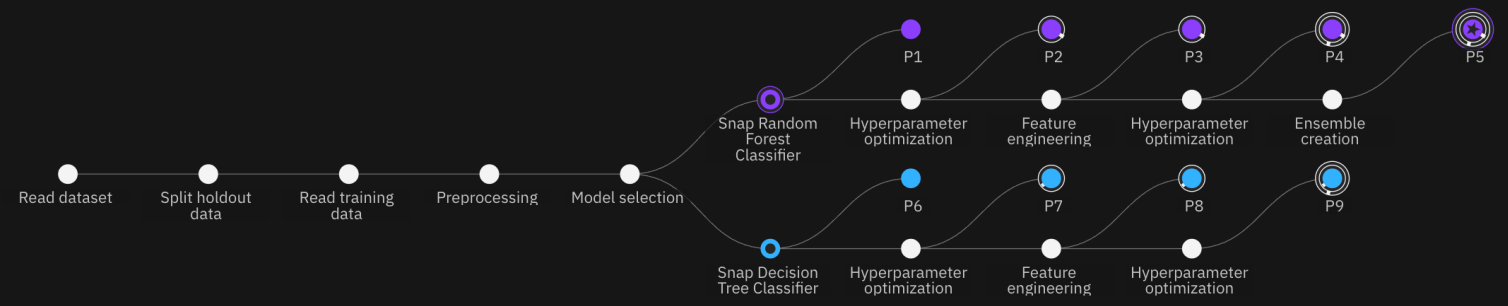
IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / predictive_maintainance

Experiment summary | Pipeline comparison | ★ Rank by: Accuracy (Optimized) | Cross validation score

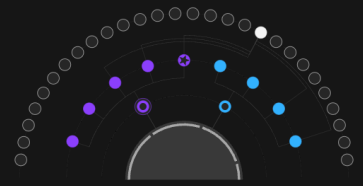
Progress map

Prediction column: Failure Type



Relationship map

Swap view



Experiment completed

9 PIPELINES GENERATED

9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.

Time elapsed: 9 minutes

View log | Save code

Pipeline leaderboard

Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
6	Pipeline 1	Snap Random Forest Classifier		0.994	None	00:00:03

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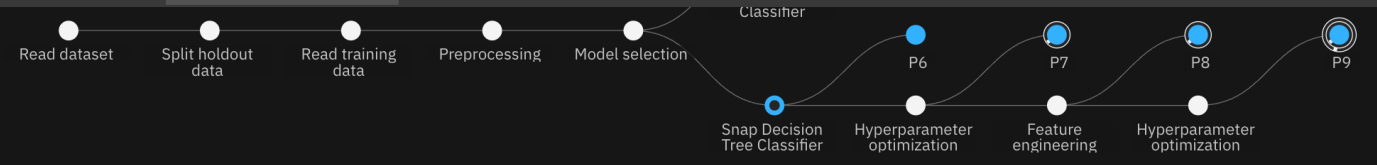
Service Details - IBM Cloud | IBM watsonx.ai Studio | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml/auto-ml/b214f867-ce0a-4a4f-90a7-10bb0b5217d9/train?projectid=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&context=c...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / predictive_maintainance

Experiment summary | Pipeline comparison | Rank by: A



Saved Model successfully.
P5 - Snap Random Forest Classifier: predictive_maintainance was successfully saved to final_project.

View in project

Time elapsed: 9 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	00:02:19
	2	Pipeline 4	Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:02:15
	3	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:01:17
	4	Pipeline 9	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:03

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Service Details - IBM Cloud | P5 - Snap Random Forest Cla | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/models/ceb0449f-f977-4570-829f-a6bfbde8ac1e?project_id=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&conte...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / P5 - Snap Random Forest Classifier: predictive_maintainance

Input (1)

Column	Type
Air temperature [K]	double
Process temperature [K]	double
Product ID	other
Rotational speed [rpm]	double
Target	double
Tool wear [min]	double
Torque [Nm]	double
Type	other

About this asset

Name

P5 - Snap Random Forest Classifier: predictive_maintainance

Description

No description provided.

Asset Details

Type: wml-hybrid_0.1

Model ID: `ceb0449f-f977-45...`

Software specification: hybrid_0.1

Hybrid pipeline software specifications: autoai-kb_rt24.1-py3.11

Tags

Add tags to make assets easier to find.

Last modified
15 seconds ago by Service

Created on
Aug 3, 2025 by Parivesh Tiwari

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Service Details - IBM Cloud | P5 - Snap Random Forest Cla | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/models/ceb0449f-f977-4570-829f-a6bfbde8ac1e?project_id=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&conte... Incognito

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / P5 - Snap Random Forest Classifier: predictive_maintainance

Promote to space

Promote the asset to a deployment space to deploy the asset or to support a deployment.

Create a deployment space

Use a space to collect assets in one place to create, run, and manage deployments

+ New

Local file

Define details

Name

Predictive_Maintainance_Dep1

Description (Optional) 0/100

What's the purpose of this space?

Deployment stage

Select or enter a name that describes the purpose of the space

Select or enter a name that describes the purpose of the space

Cancel

Creat

Chrome File Edit View History Bookmarks Profiles Tab Window Help 37% Sun 3 Aug 2:05 PM

Service Details - IBM Cloud | P5 - Snap Random Forest Cla | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/models/ceb0449f-f977-4570-829f-a6bfbde8ac1e?project_id=de0b0f55-9d0f-44c7-a3ef-cc04fac87eb8&conte... Incognito

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Projects / final_project / P5 - Snap Random Forest Classifier: predictive_maintainance

Promote to space

Promote the asset to a deployment space to deploy the asset or to support a deployment.

Target deployment space

Predictive_Maintainance_Dep1

Why don't I see all of my spaces?

Go to the model in the space after promoting it

Description (Optional)

Description of assets

Find or create tags

Promoting a version of an asset to a space creates a new asset in the space, with a new asset ID.

Selected assets (1)

Name	Format	Version	Status
P5 - Snap Random Forest Classifier...	Model	Curr...	Queued

Promoting an asset promotes dependent assets as well. For example, promoting a model also promotes the associated software specification and package extensions. You will see all promoted assets in the target space.

Cancel

Promote

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Service Details - IBM Cloud | P5 - Snap Random Forest Cla | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/models/c135ebe3-13d8-411d-a5f9-4c9e5a6405f0?space_id=61d8274c-aafb-4019-ab50-1171d8a8fdb2&context...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Deployment spaces / Predictive_Maintainance_Dep1 / P5 - Snap Random Forest Classifier: predictive_maintainance

Create a deployment

Define details

Associated asset
P5 - Snap Random Forest Classifier: predictive_maintainance

Deployment type

Online
Run the model on data in real-time, as data is received by a web service.

Batch
Run the model against data as a batch process.

Name
predictive_maintainance_dep

Serving name
Deployment serving name

Enter a short name to be used as the serving name for the deployment. The name must be unique to be valid.

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Service Details - IBM Cloud | P5 - Snap Random Forest Cla | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/models/c135ebe3-13d8-411d-a5f9-4c9e5a6405f0/deployments?space_id=61d8274c-aafb-4019-ab50-1171d8a8...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Deployment spaces / Predictive_Maintainance_Dep1 / P5 - Snap Random Forest Classifier: predictive_maintainance

Deployments | Model details

Search | New deployment

Name	Type	Status	Tags	Last modified
predictive_maintainance_dep	Online	Deployed		21 seconds ago Parivesh Tiwari (You)

Items per page: 20 | 1–1 of 1 items | 1 of 1 pages

About this asset

Name
P5 - Snap Random Forest Classifier: predictive_maintainance

Description
No description provided.

Asset Details
Type: wml-hybrid_0.1
Model ID: `c135ebe3-13d8-41...`
Software specification:
hybrid_0.1
Hybrid pipeline software specifications:
autoai-kb_rt24.1-py3.11

Tags
Add tags to make assets easier to find.

Source asset details

Last modified
7 minutes ago by Service

Created on
Aug 3, 2025 by Parivesh Tiwari

Chrome File Edit View History Bookmarks Profiles Tab Window Help 30% Sun 3 Aug 3:34 PM

Service Details - IBM Cloud | predictive_maintainance_dep | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/deployments/de04437d-08f7-460a-9da8-b8a1c379ddea/test?space_id=61d8274c-aafb-4019-ab50-1171d8a8fd...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Deployment spaces / Predictive_Maintainance_Dep1 / P5 - Snap Random Forest Classifier: predictive_maintainance /

predictive_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.

Clear all ×

	UDI (double)	Product ID (other)	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)
1	16	L47195	L	298.6	309.2	1547	48.4
2	409	M15268	M	297.4	308.6	1434	44.4
3	497	M15356	M	297.5	309.2	1530	40
4	70	L47249	L	298.9	309	1410	65.7
5	54	L67678	L	400	399	1989	70
6	65	M65680	L	256.9	490	2100	67.6
7							

6 rows, 9 columns

Predict

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Service Details - IBM Cloud | predictive_maintainance_dep | Settings | IBM watsonx.ai Stu

au-syd.dai.cloud.ibm.com/ml-runtime/deployments/de04437d-08f7-460a-9da8-b8a1c379ddea/test?space_id=61d8274c-aafb-4019-ab50-1171d8a8fd...

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | Parivesh Tiwari's Account | Sydney | PT

Deployment spaces / Predictive_Maintainance_Dep1 / P5 - Snap Random Forest Classifier: predictive_maintainance /

Prediction results

Close

Prediction type

Multiclass classification

Display format for prediction results

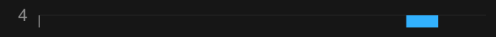
Table view | JSON view

Show input data

Prediction percentage

No Failure | Power Failure

Confidence level distribution



	Prediction	Confidence
1	No Failure	100%
2	No Failure	100%
3	No Failure	100%
4	Power Failure	100%
5	Power Failure	60%
6	No Failure	50%
7		
8		
9		
10		
11		
12		

Download JSON file

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THANK YOU

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