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# **CAPSTONE PROJECT**

## **Problem statement 39: Predictive Maintenance of Industrial Machinery**

**Presented By:**

**1. Bharath Prabhu - VIT Chennai - CSE\_AIML**

# OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result
- Conclusion
- Future Scope
- References

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# 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

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.

The solution will consist of the following components:

→ **Data Collection:**

- ◆ Use Kaggle Dataset on Machine Predictive Maintenance Classification.

→ **Data Preprocessing:**

- ◆ Clean and preprocess the collected data to handle missing values, outliers, and inconsistencies.
- ◆ Feature engineering to extract relevant features from the data that might impact bike demand.

→ **Machine Learning Algorithm:**

- ◆ Implement a machine learning algorithm, such as a classification model like Random Forest Classifier or Decision Tree

→ **Evaluation:**

- ◆ Validate the model using Accuracy, precision, recall, f1-score, etc

# SYSTEM APPROACH

The overall approach for developing and implementing the “Predictive Maintenance of Industrial Machinery” system are:

- System requirements:
  - IBM Cloud
  - IBM Watson Studio
  - IBM Cloud Object Storage for Dataset Handling
- Models Used:
  - Random Forest Classifier and its variations
  - Decision Tree and its variation

# ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**

- Various pipelines with different base algorithm and modifications will be performed and the one with the best accuracy will be chosen.

- **Data Input:**

- Kaggle dataset “Machine Predictive Maintenance Classification” has the following data columns:
- Product Type, Air temperature [Kelvin], Process temperature [Kelvin], Rotational speed [rpm], Torque [Nm], Tool wear [min], Target


- **Training Process:**


- IBM Watson Studio powered - “Automatic Machine Learning Model Build” option.
- Follows supervised learning using the input data and the label entry “Failure Type”.

- **Prediction Process:**


- Model deployed on IBM Watson studio with API endpoint for real-time predictions.


# RESULT - New Project Creation

 IBM watsonx.ai Studio

 Search in your workspaces

Upgrade







Bharath Prabhu's Account ▾


Sydney ▾


BP





Projects / Predictive Maintenance of Industrial Machinery - PROJECT


 ▾















Overview Assets Jobs Manage

Start working Recommended ▾

  
Add users as collaborators →


  
Add data to work with →

  
Work with data and models in Python or R notebooks →

  
Build machine learning models automatically →

[View all](#)

[Collapse](#) ^

**Assets** By all ▾  
Assets that you create with tools show here. See all assets, including data assets, on the Assets page.  


**Resource usage** ⓘ  
For this month in this project  
0 CUH

**Your documentation** New!  
Get started with your documentation  
You can create and manage documents about work that you do in this project.  
[Open Documentation editor](#) →

# RESULT - Runtime Added

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Overview

Assets

Jobs

Manage

Project

General

Access control

Environments

Resource usage

Services & integrations

Tools

Pipeline

Services & integrations

IBM services (1)

Third-party integrations

Associate IBM Cloud services with this project to add tools, compute environments, or other capabilities.[Learn more.](#)

Find services

Associate service

<input type="checkbox"/>	Name	Service type
<input type="checkbox"/>	watsonx.ai Runtime-bk	watsonx.ai Runtime



# RESULT - Building the ML Model

IBM watsonx.ai Studio

Search in your workspaces

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?

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Projects / Predictive Maintenance of Industrial Machinery - PROJECT

Build machine learning models automatically

Define the details to create an AutoAI experiment asset and open it in the AutoAI tool.

+ New

Sample

Define details

Name

Predictive Maintenance of Industrial Machinery - ML

Description (optional)

IBM SKILLSBUILD INTERNSHIP FINAL PROJECT

Tags (optional)

Add tags to make assets easier to find.

Start typing to add tags

Define configuration

watsonx.ai Runtime service instance

watsonx.ai Runtime-bk

Environment definition

Large: 8 CPU and 32 GB RAM

This environment definition consumes **20 capacity units per hour** for training. For details, see [watsonx.ai Runtime plans](#).

Cancel

Back

Create

# RESULT - Upload the dataset

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Projects / Predictive Maintenance of Industrial Machinery - PROJECT / Predictive Maintenance of Industrial Machinery - ML     

Configure AutoAI experiment

## Predictive Maintenance of Industrial Machinery - ML

### Add data source

Add files such as tabular data (CSV).

Browse

Select from project



predictive\_maintenance.csv

Size: 518.57 KB



### Configure details



#### No user API key

To create an AutoAI machine learning experiment you must first [create a User API key](#). Then, click the [reload button](#).



#### 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

# RESULT - API KEY CREATED



Bharath Prabhu

bharath.prabhu2021@vitstudent.ac.in

[Edit IBMid profile](#) 

☐ Dark theme off

## Profile





## Git integrations

User API key

✔ **User API key is successfully created.**  
Your new key is stored in IBM watsonx.ai Studio and IBM Cloud.

User API key

A user API key is required to authenticate runtime operations in IBM watsonx.ai Studio. Rotate keys as needed to create a new key and phase out the current key. [Learn more](#)

			<a href="#">Rotate</a> 	
Name	Creation date	Status		
<div></div>	August 4, 2025 at 3:00:36 AM	 Active		

# RESULT - Select Label to predict

Configure AutoAI experiment

## Predictive Maintenance of Industrial Machinery - ML

Autosaved: 3:03:09 AM

### 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](#)



#### 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

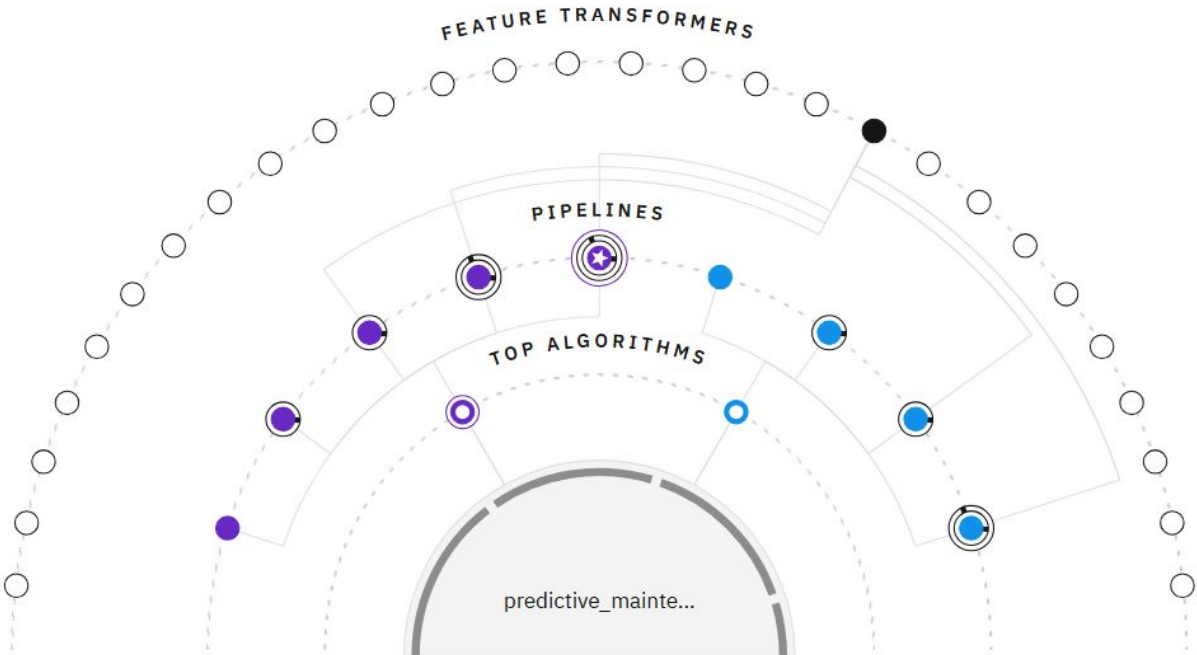
Experiment settings 

Run experiment

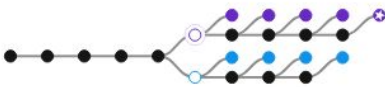


# RESULT - Relationship Map

Relationship map ⓘ  
Prediction column: Failure Type



Progress map  
[Swap view](#)



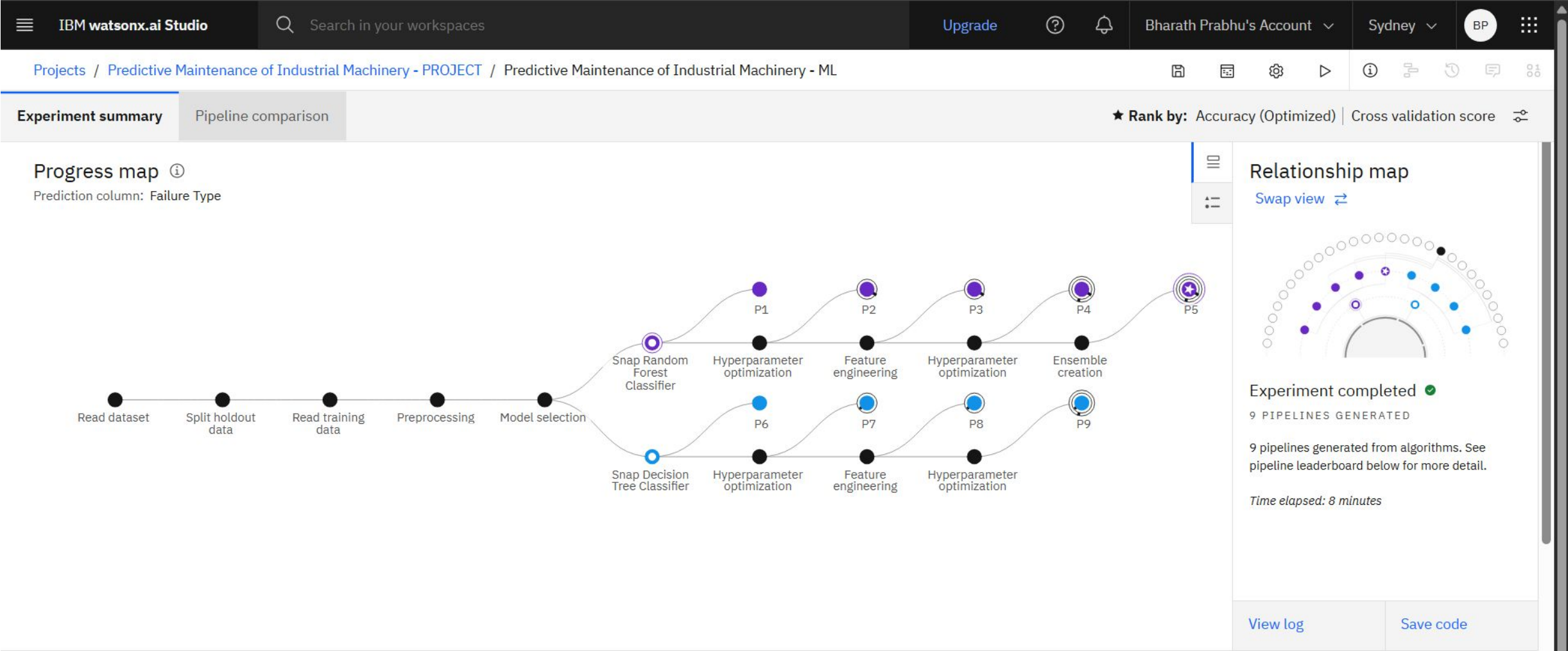
Experiment completed ✓  
9 PIPELINES GENERATED  
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.  
Time elapsed: 8 minutes

[View log](#) [Save code](#)

Pipeline leaderboard ⌵

Rank	↑	Name	Algorithm	Specialization	Accuracy (Optimized)	Enhancements	Build time
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# RESULT - Progress Map














## Pipeline leaderboard

Rank	↑	Name	Algorithm	Specialization	Accuracy (Optimized)	Enhancements	Build time
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# RESULT - Pipeline Performance Leaderboard

Pipeline leaderboard 

	Rank 	Name	Algorithm	Specialization	Accuracy (Optimized) <small>Cross Validation</small>	Enhancements	Build time
★	1	Pipeline 5	 Batched Tree Ensemble Classifier (Snap Random Forest Classifier)	INCR	0.995	HPO-1 FE HPO-2 BATCH	00:01:35
	2	Pipeline 4	 Snap Random Forest Classifier		0.995	HPO-1 FE HPO-2	00:01:32
	3	Pipeline 3	 Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:33
	4	Pipeline 9	 Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:03
	5	Pipeline 2	 Snap Random Forest Classifier		0.994	HPO-1	00:00:09
	6	Pipeline 1	 Snap Random Forest Classifier		0.994	None	00:00:02
	7	Pipeline 8	 Snap Decision Tree Classifier		0.993	HPO-1 FE	00:02:50
	8	Pipeline 7	 Snap Decision Tree Classifier		0.991	HPO-1	00:02:29
	9	Pipeline 6	 Snap Decision Tree Classifier		0.988	None	00:01:36

# RESULT - Saving the best model

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Experim

Pipe

★

## Save as

### Select asset type

**Model**

Create a watsonx.ai Runtime model asset that you can test with new data, deploy to generate predictions, and trace lineage activity.

**Notebook**

Create a notebook if you want to view the code that created this model pipeline or interact with with the model programmatically.

### Define details

Name

P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery

Description (optional)

Best pipeline with 0.995 accuracy.  
uses HPO-1, FE, HPO-2, BATCHING

Tags

Add tags to make assets easier to find.

Add a tag

Cancel

Create



# RESULT - Deployment and Promoting to Space

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Projects / ... / P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery - ML

Inp

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Target

Tool

Torqu

Type

## Promote to space

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

Target deployment space

ictive\_Maintenance\_of\_Industrial\_Machinery\_Deployment

Create a new deployment space

Predictive\_Maintenance\_of\_Industrial\_Machinery\_Deployment

Description (Optional)

Description of assets

Find or create tags

Selected assets (1)

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

# RESULT - Model Successfully Deployed

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Deployment spaces /

Predictive\_Maintenance\_of\_Industrial\_Machinery\_Deployment

OverviewAssetsDeploymentsJobsManage

Find assets

Import assets

New asset

1 asset

All assets

Asset types

Models

All assets

Name

Last modified

P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery - ML

Machine learning model from AutoAI

11 seconds ago Service

Items per page: 20

1-1 of 1 items

1 of 1 pages

# RESULT - Associating Runtime to our Model

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Deployment spaces /

Predictive\_Maintenance\_of\_Industrial\_Machinery\_Deployment

OverviewAssetsDeploymentsJobsManage

Space

fc6296a5-edb0-452e-bf46-254186a2c935

General

Access control

Environments

Resource usage

Date created

Aug 4, 2025, 3:31 AM

by Bharath Prabhu (You)

Stage

Not provided

Tags

No tags are set to this space.

Space GUID

fc6296a5-edb0-452e-bf46-254186a2c935

Date created

Aug 4, 2025, 3:31 AM

by Bharath Prabhu (You)

Last updated

Aug 4, 2025, 3:31 AM

Stage

Not provided

Stage type

Pre-production

Controls

Cloud Pak for Data platform

Switch platform

Reporting on asset metadata is allowed

Grant access

Bucket

fd163580-a83a-4ec9-afcc-1af735e92b26

Manage in IBM Cloud

watsonx.ai Runtime service


Cancel

Save

watsonx.ai Runtime-bk

Create a new watsonx.ai Runtime service

watsonx.ai Runtime-bk



# RESULT - Creating a New Deployment

IBM watsonx.ai Studio

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Deployment spaces / ... / P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery - ML

Deployment spaces

Create a deployment

Define details

Associated asset

P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery - ML

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

Deployment 2 - Predictive Maintenance of Industrial Machinery

Serving name

Deployment serving name

Cancel

Create

# RESULT - TESTING WITH USER INPUTS

## Deployment 2 - Predictive Maintenance of Industrial Machinery ✔ 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	1	M14872	M	298.6	309.1	1339	51.1
2	2	H33243	H	302.3	310.9	1366	48.4
3	3	L47560	L	297.5	308.3	2564	12.8

5 rows, 9 columns

Predict

# RESULT - Test Results/Predictions

IBM watsonx.ai Studio

Search in your workspaces

Upgrade

?

1

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Deployment spaces / Predictive\_Maintenance\_of\_Industrial\_Machinery\_Deployment / P5 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery - ML /

Prediction results

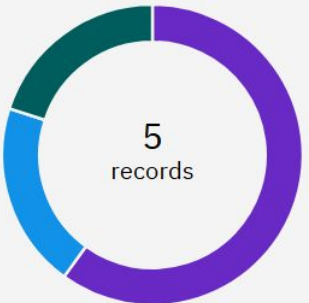
Close

×

Prediction type

Multiclass classification

Prediction percentage



5 records

No Failure

Heat Dissipation Failure

Power Failure

Display format for prediction results

☒ Table view ☐ JSON view

☐ Show input data ⓘ

	Prediction	Confidence
1	No Failure	100%
2	Heat Dissipation Failure	100%
3	Power Failure	100%
4	No Failure	100%
5	No Failure	100%
6		
7		
8		
9		
10		
11		

Download JSON file

---

# CONCLUSION

The predictive maintenance model for industrial machinery successfully leverages real-time sensor data to anticipate potential equipment failures. By using IBM Watson Studio's AutoAI functionality, we explored multiple algorithmic pipelines and selected the one with the best accuracy for classifying failure types such as tool wear, heat dissipation issues, and power failures. The model enables timely and proactive maintenance by identifying early warning signs from features like air temperature, torque, and tool wear. The deployment through an API endpoint allows seamless integration into industrial monitoring systems, significantly reducing unexpected downtime and enhancing overall operational efficiency.

# FUTURE SCOPE

- **Incorporation of Time-Series Data:**

- Future iterations can include time-series analysis to detect gradual trends and degradation patterns over extended operational periods.

- **Multi-Sensor Integration:**

- Expanding the dataset to include additional sensor types such as vibration, acoustic signals, or infrared imaging could improve the robustness and accuracy of the model.

- **Automated Maintenance Trigger System:**

- Integrate the prediction outputs with an automated workflow that schedules maintenance or sends alerts to technicians in real-time.

- **Self-Learning Feedback Loop:**

- Implement a feedback system where the model updates itself based on new failure events, continuously improving its accuracy over time with minimal human intervention.

- **Cross-Factory Generalization:**

- Train and test the model on datasets from different types of machines and manufacturing environments to ensure scalability and generalization.



# REFERENCES

- Dataset: <https://www.kaggle.com/datasets/shivamb/machine-predictive-maintenance-classification?resource=download>
- Tools: <https://cloud.ibm.com/>

# IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence



## Bharath Prabhu

Has successfully satisfied the requirements for:

### Getting Started with Artificial Intelligence



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IBM **SkillsBuild**

Completion Certificate



This certificate is presented to

Bharath Prabhu

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**