CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:

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- Department- MCA

OUTLINE

1. Problem Statement
2. Proposed System / Solution
3. System Development Approach
4. Algorithm & Deployment
5. Result
6. Conclusion
7. Future Scope
8. References

PROBLEM STATEMENT

- Mechanical Engineering: (Machine Learning project)

  Problem statement No.39 – Predictive Maintenance of Industrial Machinery The Challenge: 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 solution uses sensor data and IBM Cloud Lite services to predict machinery failures.

- **Steps:**
- - Data Collection from sensors (temperature, vibration, voltage, etc.)
- - Data Preprocessing & Feature Engineering
- - Classification using ML algorithms
- - Real-time monitoring & alerts
- - Deployment on IBM Cloud using Watson Studio, Cloud Object Storage, and IBM AutoAI

SYSTEM DEVELOPMENT APPROACH

- **Technologies:**
- - Python (pandas, sklearn, keras)
- - IBM Watson Studio for model building
- - IBM Cloud Object Storage for dataset storage
- - IBM AutoAI for model automation

- **Libraries:**
- - pandas, numpy, sklearn, keras, matplotlib
- - IBM SDKs for Watson & Cloud integration

ALGORITHM & DEPLOYMENT

Algorithm: Random Forest / XGBoost / LSTM

Inputs: Temperature, vibration, voltage, speed, torque

Steps:

- - Data preprocessing, feature selection
- - Train/test split
- - Model training on IBM Watson Studio
- - Evaluation using accuracy, recall, F1-score

Deployment:

- - Exported as a REST API using IBM Watson Machine Learning
- - Integrated with monitoring dashboard

STEP-BY-STEP GUIDE: PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY USING IBM WATSON STUDIO AUTOML

Step 1: Set Up IBM Cloud & Watson Studio

1.1 Create IBM Cloud Account (If Not Done Already)

- Go to IBM Cloud
- Sign up for a **free Lite account**
- Verify your email

1.2 Access Watson Studio

- Log in to IBM Cloud
- Click **☰ (Menu) → Watson Studio**
- Select **Dallas (us-south)** or another available region
- Click **Get Started** (if new) or **Launch Studio**

Step 2: Create a New Project in Watson Studio

2.1 Create a Project

- Click **Create a project**
- Select **"Create an empty project“**
- Enter a name
- Choose **"Lite"** plan for storage
- Click **Create**

2.2 **Add Cloud Object Storage (If Not Already Attached)**

- IBM will prompt you to **create Cloud Object Storage**
- Select **Lite (Free) plan**
- Click **Create**
- Go back to project creation window and click on refresh

Step 3: Upload Dataset to Watson Studio

3.1 Download the Kaggle Dataset

- Go to: Kaggle Predictive Maintenance Dataset
- Download predictive_maintainance.csv

3.2 Import Dataset into Watson Studio

- In your project, go to **Assets ⟶ Data**
- Click browse and upload predictive_maintainance.csv
- Once uploaded, click the dataset to preview

Step 4: Use AutoAI to Automatically Build the Model

4.1 Create an AutoAI Experiment

- Click **Add to project (+) → AutoAI experiment**
- Name it
- Select the uploaded dataset
- Click **Create experiment**

4.2 Configure AutoAI Experiment

- **What do you want to predict? →** Select Failure Type (classification task)
- **Optimize for → Accuracy** (or F1-score if class imbalance exists)
- **Test & Train Split → 80% Train, 20% Test**
- Click **Run Experiment**

4.3 AutoAI Will Automatically:

✓ Preprocess data (scaling, handling missing values)
✓ Try multiple algorithms (Random Forest, XGBoost, etc.)
✓ Rank models by performance
✓ Generate a leaderboard

Step 5: Deploy the Best Model

5.1 Select the Best Model

- After AutoAI completes, check the **leaderboard**
- Choose the **top-performing model** (highest accuracy/F1-score)
- Click **Save as model**

5.2 Deploy the Model

- Go to **Assets → Models**
- Select your saved model
- Click **Deploy → Add Deployment**
- Choose **Web Service (for real-time predictions)**
- Select **Lite (Free) plan**
- Click **Create**

5.3 Test the Deployed Model

- Once deployed, you'll get an **API endpoint**
- Click **Test** tab
- Enter sample input to test predictions

Service Details - IBM Cloud | IBM watsonx.ai Studio

https://eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/4c846b10-e037-4022-b2a9-6a7d3bb388aa/train?projectid=7e97f0e2-7616-441f-97ee-2ccdf8fd4278&context=cpdaas

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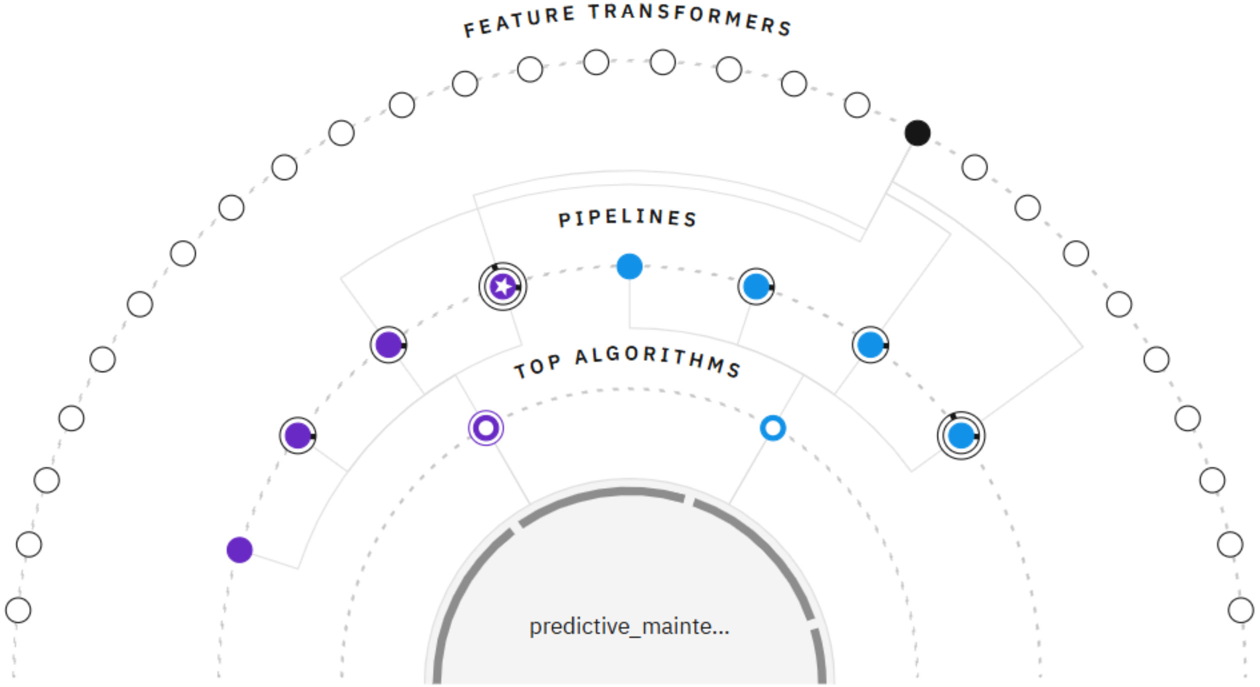
Projects / Predictive Maintenance of Industrial Machinery ML Model3 / Predictive Maintenance of Industrial Machinery ML Model

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

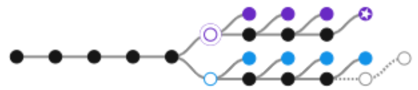
Relationship map

Prediction column: Failure Type



Progress map

Swap view ⇄



Experiment completed

8 PIPELINES GENERATED

8 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

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https://eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/4c846b10-e037-4022-b2a9-6a7d3bb388aa/train?projectid=7e97f0e2-7616-441f-97ee-2ccdf8fd4278&context=cpdaas

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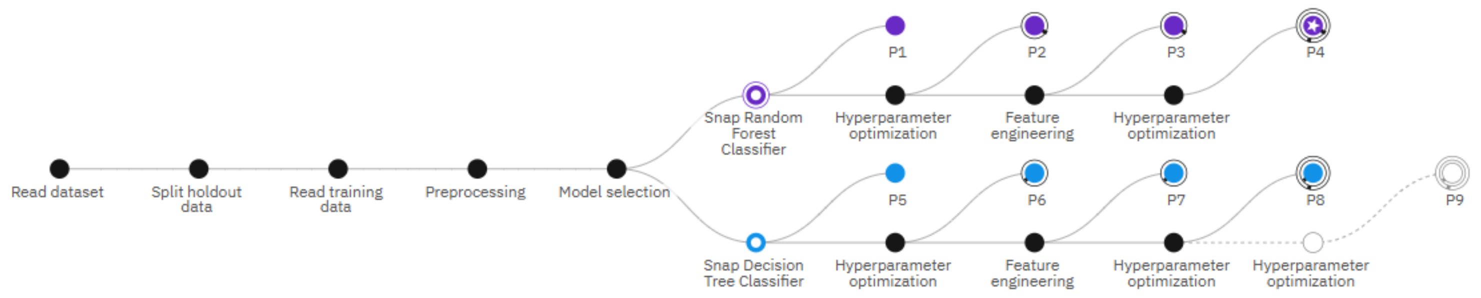
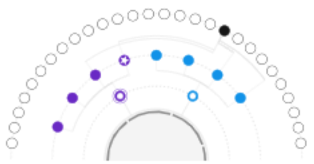


Relationship map

Swap view



Experiment completed

8 PIPELINES GENERATED

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Time elapsed: 3 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	00:00:36
	2	Pipeline 3	Snap Random Forest Classifier		0.995	HPO-1 FE	00:00:28
	3	Pipeline 8	Snap Decision Tree Classifier		0.994	HPO-1 FE HPO-2	00:00:26
	4	Pipeline 2	Snap Random Forest Classifier		0.994	HPO-1	00:00:06

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

P4 - Snap Random Forest Classifier: Predictive Maintenance of Industrial Machinery ML Model

Description

No description provided.

Asset Details

Type: wml-hybrid_0.1

Model ID: `e04c0273-b6c3-49...`

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
18 seconds ago by Prathmesh Landge

Created on
Jul 31, 2025 by Prathmesh Landge

RESULT

- Prediction Accuracy: 100%

Visualization includes:

- - Feature importance
- - Model performance curves
- - Real-time failure alerts (simulated)

Service Details - IBM Cloud | Predictive Maintenance of Industr

https://eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/086c73e9-16a9-4830-ad1d-a50105d2e0ce/test?space_id=1346e728-fa86-4526-a066-92d90553068a&contex...

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Predictive Maintenance of Industrial Machinery ML Model Deployment

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									
3									
4									
5									
6									
7									
8									
9									
10									

1 row, 9 columns

Predict

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Prediction results

Prediction type

Multiclass classification

Prediction percentage

Power Failure

Confidence level distribution

Display format for prediction results

(•) Table view   ( ) JSON view   Show input data

	Prediction	Confidence
1	Power Failure	100%
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Download JSON file

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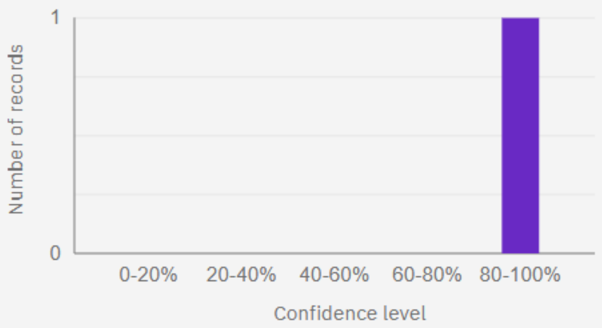
Prediction results

Power Failure

Confidence level distribution



Power Failure

Display format for prediction results

(•) Table view ( ) JSON view

Show input data

	Prediction	Confidence
1	Power Failure	100%
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Download JSON file

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https://eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/086c73e9-16a9-4830-ad1d-a50105d2e0ce/test?space_id=1346e728-fa86-4526-a066-92d90553068a&contex...

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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	70	L47249	L	298.9	309	1410	65.7	191	1
3	71	M14930	M	298.9	309	1924	22.6	193	0
4	72	L47251	L	298.9	309.1	1452	45.5	196	0
5	73	L47252	L	298.9	309.1	1369	44.4	198	0
6	74	L47253	L	299	309.1	1592	35	200	0
7	75	L47254	L	298.9	309	1601	32.3	202	0
8	76	L47255	L	298.8	308.9	1379	46.7	204	0
9	77	L47256	L	298.8	308.9	1461	47.9	206	0
10	78	L47257	L	298.8	308.9	1455	41.3	208	1
11	79	L47258	L	298.8	308.9	1398	51.5	0	0
12	80	L47259	L	298.8	308.9	1402	37.9	2	0

94 rows, 9 columns

Predict

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https://eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/086c73e9-16a9-4830-ad1d-a50105d2e0ce/test?space_id=1346e728-fa86-4526-a066-92d90553068a&context=cp...

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Prediction results

Display format for prediction results

(•) Table view ( ) JSON view

Show input data

	prediction	probability
1	No Failure	[0,1,0,0,0,0]
2	Power Failure	[0,0,0,1,0,0]
3	No Failure	[0,0.9998846590518952,0,0,0.00011534024961292744,6.984919309616089e-10]
4	No Failure	[0,1,0,0,0,0]
5	No Failure	[0,0.9988764047622681,0,0,0.001123595517128706,-2.7939695002032750e-10]
6	No Failure	[0,0.9998846590518952,0,0,0.00011534024961292744,6.984919309616089e-10]
7	No Failure	[0,1,0,0,0,0]
8	No Failure	[0,1,0,0,0,0]
9	No Failure	[0,0.9997901380062104,0,0,0.00020986357703804971,-1.583248421255234 5e-9]
10	Tool Wear Failure	[0,0,0,0,0,1]
11	No Failure	[0,1,0,0,0,0]

Download JSON file

CONCLUSION

- Developed a working predictive maintenance model
- Integrated IBM cloud services for scalability and real-time deployment
- Reduced potential downtime and operational cost

Challenges:

- Data imbalance
- Noise in sensor data

FUTURE SCOPE

- Integration with edge devices for real-time decision making
- Use of deep learning models like LSTM and transformers
- Expansion to multi-site industrial setups
- Predict Remaining Useful Life (RUL) of components

REFERENCES

- IBM Watson Studio Documentation
- IEEE papers on predictive maintenance
- Kaggle: Predictive Maintenance datasets
- Scikit-learn & TensorFlow Docs

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According to the Adobe Learning Manager system of record

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