CAPSTONE PROJECT

PREDICTIVE MAINTENANCE OF INDUSTRIAL MACHINERY

Presented By:
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OUTLINE

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3. System Development Approach
4. Algorithm & Deployment
5. Result
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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

- 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

Service Details - IBM Cloud | P4 - Snap Random Forest Classifie

https://eu-gb.dataplatform.cloud.ibm.com/ml-runtime/models/e04c0273-b6c3-4906-9c99-f53184c298a8?project_id=7e97f0e2-7616-441f-97ee-2ccdf8fd4278&context=cpdaas

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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

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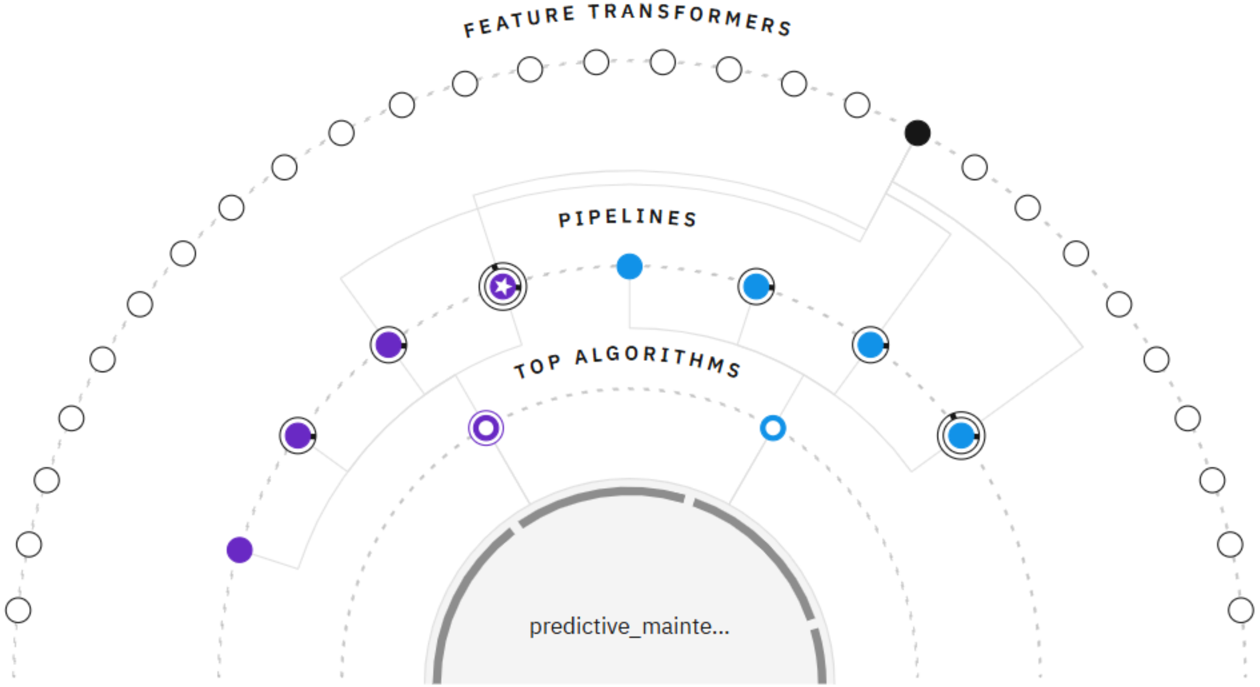
Experiment summary | Pipeline comparison

★ **Rank by:** Accuracy (Optimized) | Cross validation score

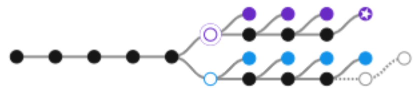
Relationship map

Prediction column: Failure Type



Progress map

Swap view ⇄



Experiment completed

8 PIPELINES GENERATED

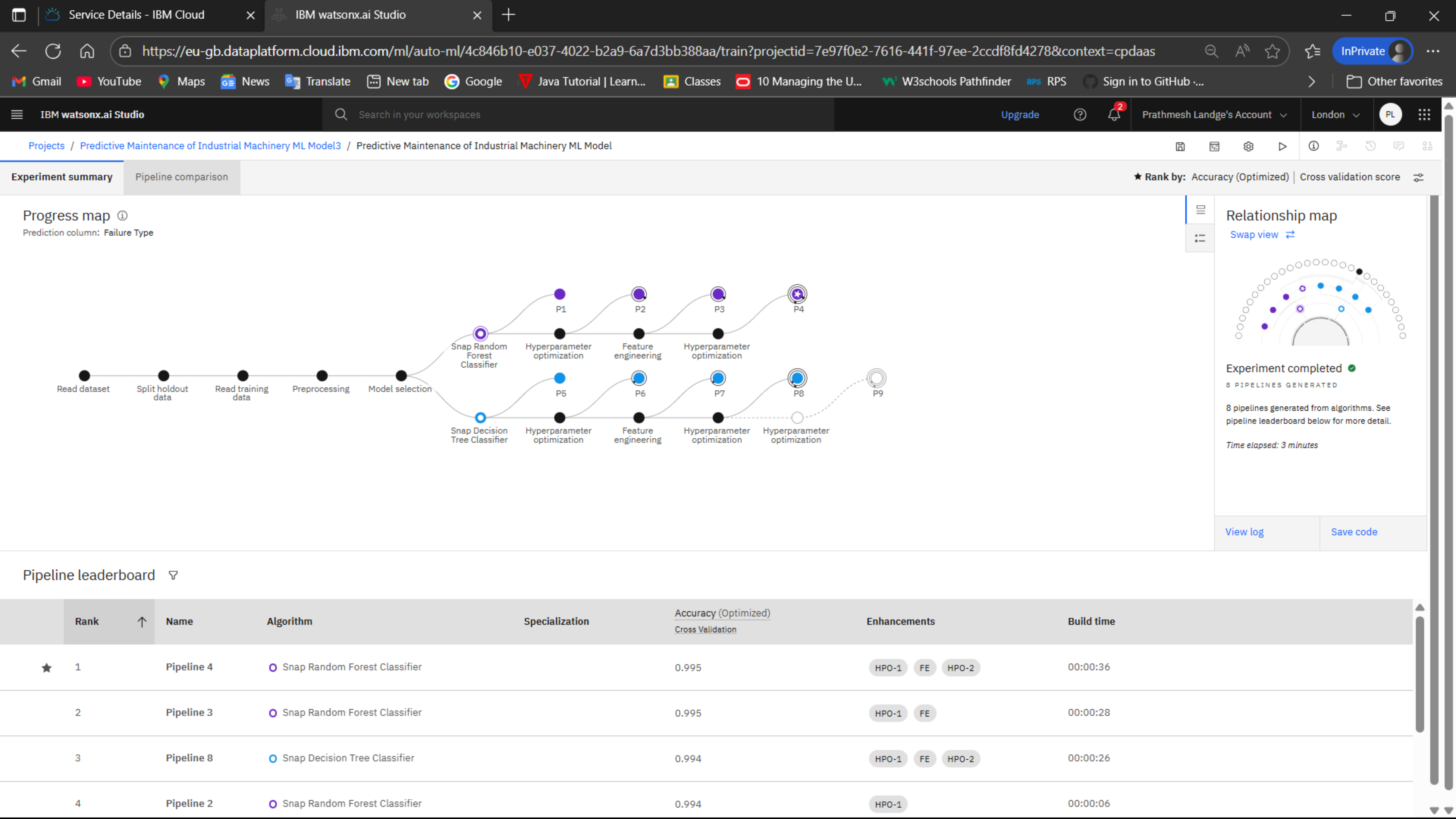
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.

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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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
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
P1
P2
P3
P4
Snap Decision Tree Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Hyperparameter optimization
P5
P6
P7
P8
P9
Relationship 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
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

RESULT

- Prediction Accuracy: 100%
- Confusion Matrix shows accurate classification of failure types
- Visualization includes:
- - Feature importance
- - Model performance curves
- - Real-time failure alerts (simulated)

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.

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	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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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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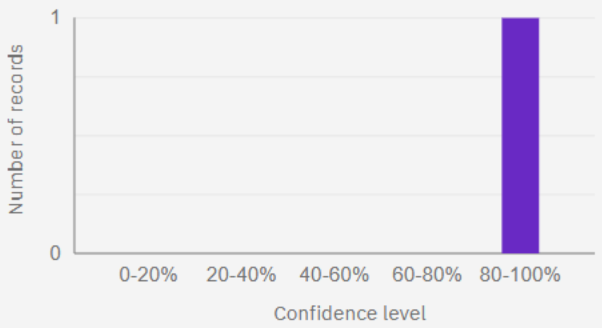
Prediction results

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.

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	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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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,-2.793969500203275e-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,-1.5832484212552345e-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

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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

THANK-YOU