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# **CAPSTONE PROJECT**

## **POWER SYSTEM FAULT DETECTION AND CLASSIFICATION**

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# OUTLINE

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

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# PROBLEM STATEMENT

Faults in a power distribution system can significantly impact the stability and reliability of the electrical grid. These faults include line-to-ground, line-to-line, and three-phase faults.

Traditional methods for fault detection and classification are often time-consuming and require manual interpretation.

The challenge is to design a machine learning model that can detect and classify such faults automatically using electrical measurement data such as voltage and current phasors.

# PROPOSED SOLUTION

The proposed system leverages a supervised machine learning model to detect and classify power system faults using features like voltage and current values. The solution includes:

- Data ingestion from a fault dataset (Kaggle)
- Preprocessing and feature extraction
- Training classification models (e.g., Decision Tree, Random Forest, SVM)
- Evaluating model performance
- Deploying the model using IBM Cloud Lite services

# SYSTEM APPROACH

## System Requirements:

- IBM Cloud (Lite Version)
- Python 3.x
- IBM Watson Studio
- Jupyter Notebook

## Libraries Required:

- pandas, numpy, matplotlib, seaborn
- scikit-learn
- IBM Watson Machine Learning SDK

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# SYSTEM APPROACH

## Development Steps:

1. Collect dataset from Kaggle
2. Preprocess and encode the data
3. Select relevant features and apply scaling
4. Train and evaluate machine learning models
5. Deploy the model on IBM Cloud

# ALGORITHM & DEPLOYMENT

**Algorithm Chosen:** Random Forest Classifier

Reason for Selection: Performs well on classification tasks, robust to overfitting, interpretable, handles class imbalance

Input Features:

Phase voltages:  $V_a$ ,  $V_b$ ,  $V_c$

Phase currents:  $I_a$ ,  $I_b$ ,  $I_c$

Target label: Fault type

Training Process:

Train-test split (80:20)

GridSearchCV for hyperparameter tuning

Evaluation metrics: Accuracy, Precision, Recall, F1-score

# ALGORITHM & DEPLOYMENT

## Deployment:

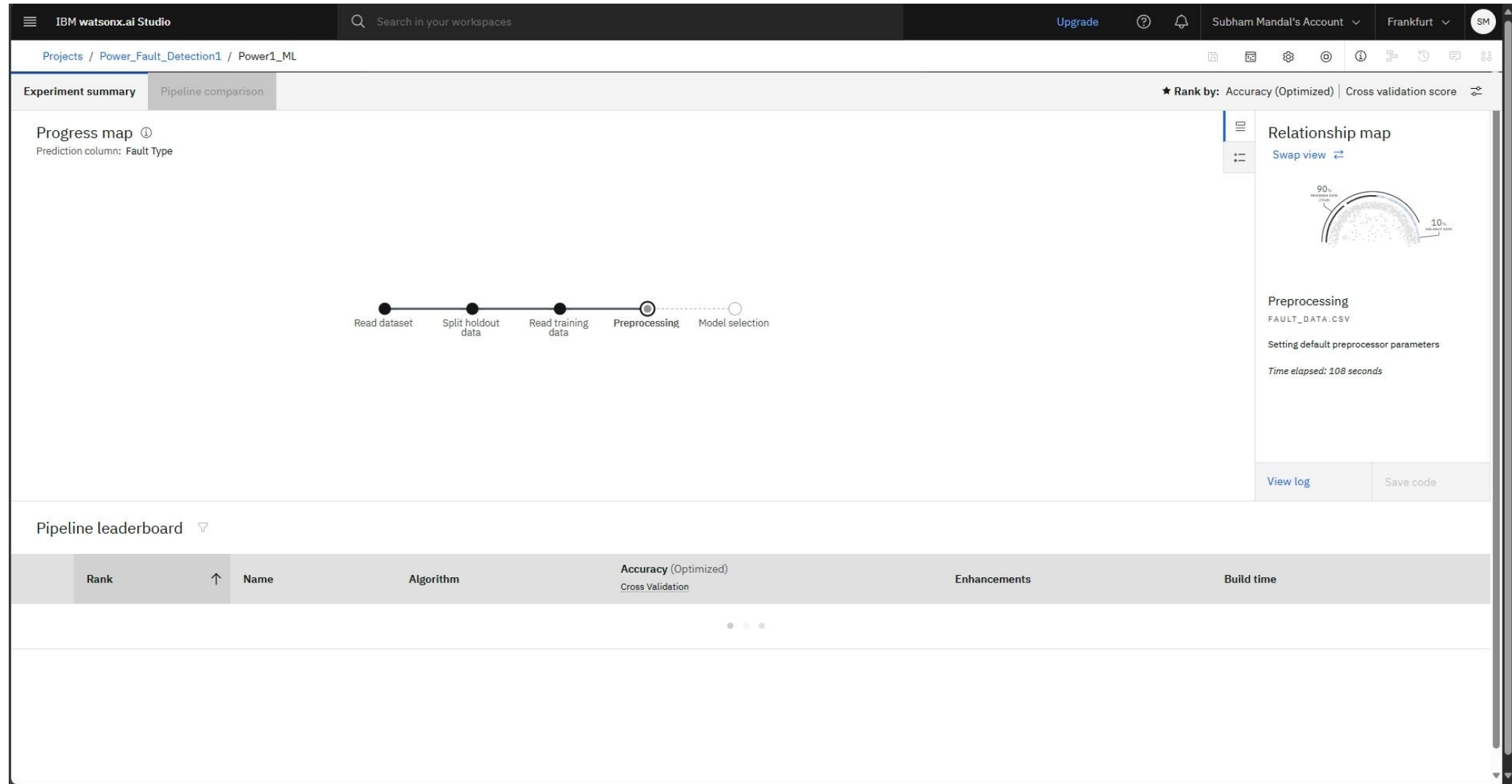
Model saved as .pkl file

Deployed using IBM Watson Machine Learning

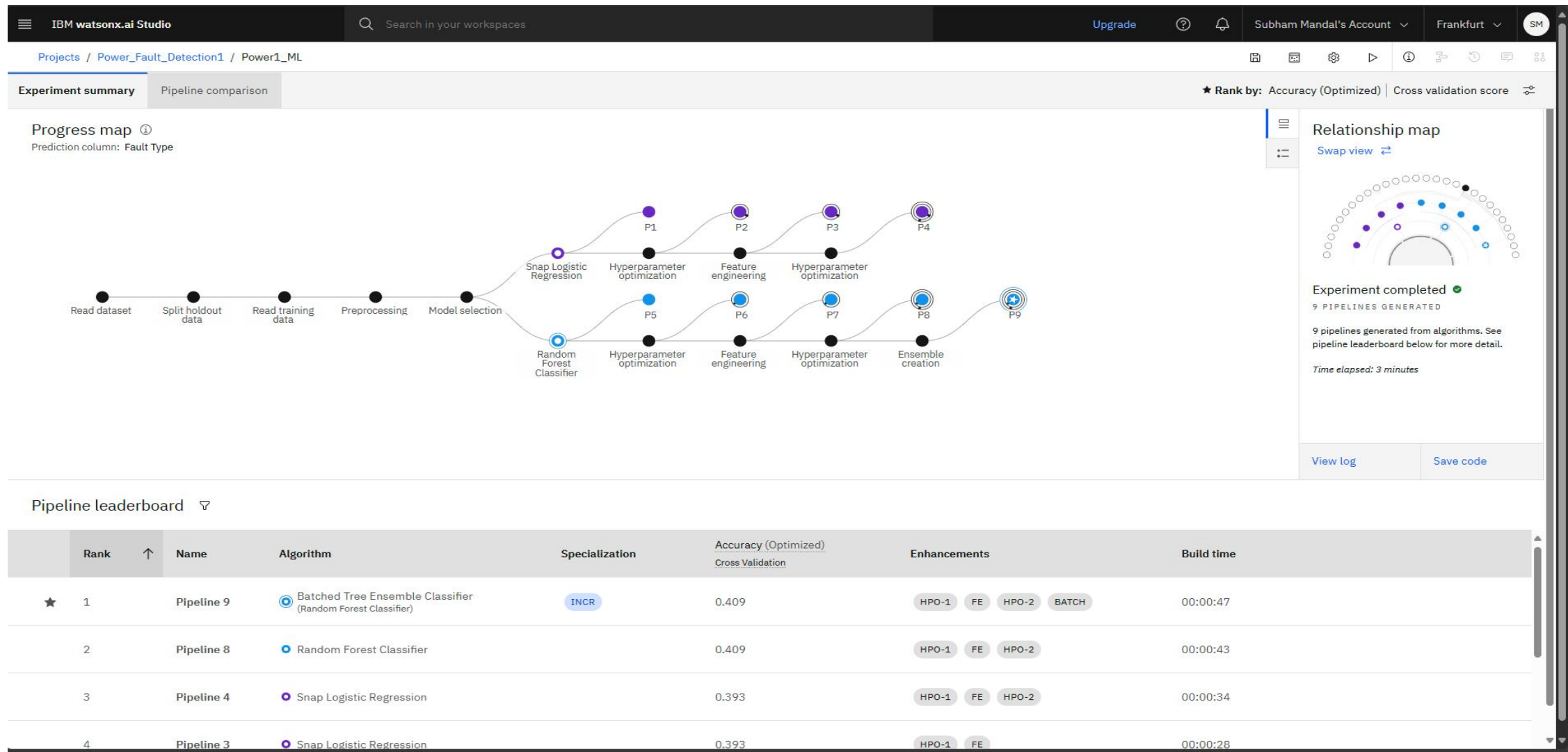
API created using IBM Cloud Functions or IBM App Runtime



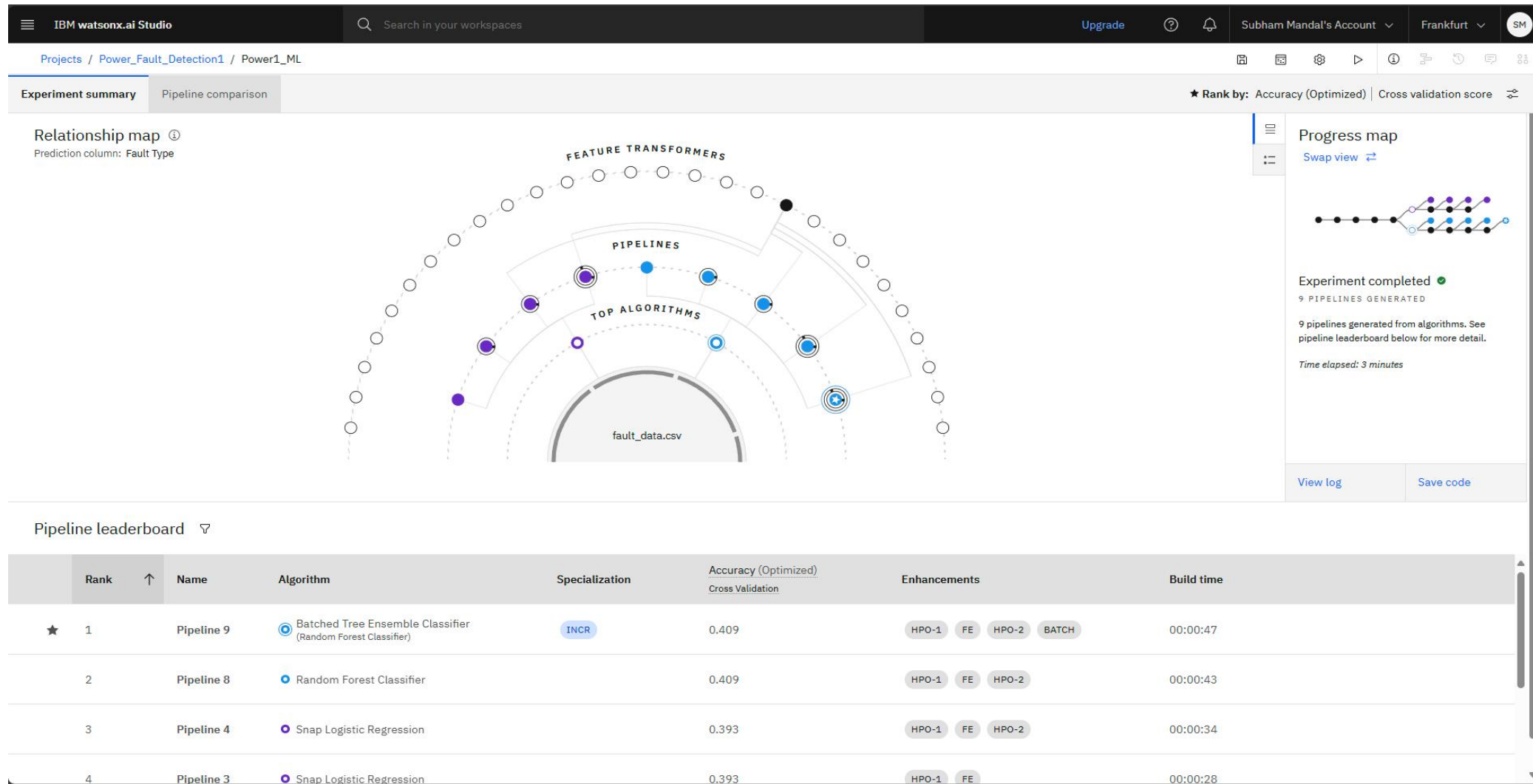
# RESULT



# RESULT



# RESULT



# RESULT

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Projects / Power\_Fault\_Detection1 / P9 - Random Forest Classifier: Power1\_ML

Promote to space

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

✔ Promotion completed.

Selected assets (1)

Name	Format	Version	Status
P9 - Random Forest Classifier: Power1_ML	Model	Current	Promoted ✔

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.

Close

✔ Success

Successfully promoted P9 - Random Forest Classifier: Power1\_ML to the deployment space. Go to the [deployment space](#) to prepare the assets for deployment.

Timestamp 12:43:34 PM

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Asset types

Models

Name	Last modified
 P9 - Random Forest Classifier: Power1_ML Machine learning model from AutoAI	60 seconds ago Service


Items per page: 201-1 of 1 items

1 of 1 pages


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Power\_Deployment2  Deployed Online

API reference

Test

Endpoints for scoring ⓘ

Private endpoint

https://private.eu-de.ml.cloud.ibm.com/ml/v4/deployments/c1c607b0-9131-49dd-b2d8-72cef489f122/predictions?version=2021-05-01

Public endpoint

https://eu-de.ml.cloud.ibm.com/ml/v4/deployments/c1c607b0-9131-49dd-b2d8-72cef489f122/predictions?version=2021-05-01

[Learn more](#) about the 2021-05-01 version query parameter

Code snippets

cURL

Java

JavaScript

Python

Scala

```
# NOTE: you must set $API_KEY below using information retrieved from your IBM Cloud account (https://eu-de.dataplatform.cloud.ibm.com/docs/content/wsj/analyze-data/ml-authentication.html?context=ibmcloud)

export API_KEY=<your API key>

export IAM_TOKEN=$(curl --insecure -X POST --location "https://iam.cloud.ibm.com/identity/token" \
--header "Content-Type: application/x-www-form-urlencoded" \
--header "Accept: application/json" \
--data-urlencode "grant_type=urn:ibm:params:oauth:grant-type:apikey" \
--data-urlencode "apikey=$API_KEY" | jq -r '.access_token')

# TODO: manually define and pass values to be scored below

curl --location "https://private.eu-de.ml.cloud.ibm.com/ml/v4/deployments/c1c607b0-9131-49dd-b2d8-72cef489f122/predictions?version=2021-05-01" \
--header "Content-Type: application/json" \
```

Show more

 Online deployment ready ⓘ

The online deployment [Power\\_Deployment2](#) in space [Power1\\_Deploy](#) is ready to accept requests

Today 12:49 PM

No description provided.

Deployment Details

Deployment ID: c1c607b0-9131-49...

Serving name: No serving name.

Software specification: [hybrid\\_0.1](#) ⓘ

Hybrid pipeline software specifications: [autoai-kb\\_rt24.1-py3.11](#)

Copies: 1

Tags

Add tags to make assets easier to find.

Associated asset ⓘ

 [P9 - Random Forest Classifier: Power1...](#)

203e3809-a3a3-4297-a4b1-543a4c2664ae

Last modified

29 seconds ago

Created on

Aug 5, 2025

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Power\_Deployment2 Deployed Online

API referenceTest

Enter input data

TextJSON

Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.

Download CSV template

Browse local files

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Clear all

	Power Load (MW) (double)	Temperature (°C) (double)	Wind Speed (km/h) (double)	Weather Condition (other)	Maintenance Status (other)	Component Health (other)	Duration of Fault (hrs) (double)	Down time (hrs) (double)
1	55	25	21	Clear	Scheduled	Normal	4	2.8
2	52	24	29	Clear	Completed	Faulty	3.9	6.4
3	48	31	26	Thunderstorm	Scheduled	Overheated	5.4	4.2
4	45	22	18	Thunderstorm	Pending	Faulty	2.8	5.4
5								
6								
7								
8								
9								
10								

4 rows, 12 columns

Predict

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Prediction results

Display format for prediction results

☒ Table view ☐ JSON view

☐ Show input data

	prediction	probability
1	Line Breakage	[0.3788542670232502,0.27647960019453144,0.34466613278221797]
2	Line Breakage	[0.4570587505245071,0.21207228993796515,0.3308689595375278]
3	Transformer Failure	[0.2738271087303065,0.3175910492052201,0.40858184206447345]
4	Line Breakage	[0.3533491393842911,0.3438863357821406,0.3027645248335681]
5		
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Download JSON file



# CONCLUSION

- The developed machine learning model successfully classifies power system faults using supervised learning techniques with high accuracy, demonstrating strong potential for real-world application. Integration with IBM Cloud enhances the solution's scalability and ease of deployment. The experiment shows that cloud-based ML models can significantly reduce fault detection time. This improvement contributes to faster response, better maintenance planning, and overall grid reliability. The approach proves both technically feasible and practically impactful. Thus, the project validates the use of ML in modern power systems for enhanced fault management.

# FUTURE SCOPE

- Integrate with real-time sensors (IoT)
- Extend to multi-region large-scale power systems
- Apply deep learning models (LSTM, CNN) for time-series based fault prediction
- Integrate with SCADA systems for industrial use
- Implement alert mechanisms using IBM Cloud functions

# REFERENCES

- Power System Faults Dataset – Kaggle
- <https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset>
- Scikit-learn Documentation
- IBM Cloud Documentation
- IEEE Research Papers on Fault Detection

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IBM **SkillsBuild**

Completion Certificate



This certificate is presented to

Subham Mandal

for the completion of

**Lab: Retrieval Augmented Generation with  
LangChain**

(ALM-COURSE\_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 30 Jul 2025 (GMT)

**Learning hours:** 20 mins



**THANK YOU**