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# **CAPSTONE PROJECT**

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

**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**

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# PROBLEM STATEMENT

Design a machine learning model to detect and classify different types of faults in a power distribution system. Using electrical measurement data (e.g., voltage and current phasors), the model should be able to distinguish between normal operating conditions and various fault conditions (such as line-to-ground, line-to-line, or three-phase faults). The objective is to enable rapid and accurate fault identification, which is crucial for maintaining power grid stability and reliability.

# PROPOSED SOLUTION

- The proposed system aims to develop a machine learning model that classifies power system faults using the dataset provided. The model will process electrical measurements to identify the type of fault rapidly and accurately. This classification will help automate fault detection and assist in quicker recovery actions, ensuring system reliability.
- The solution will consist of the following components:
- **Data Collection:**
  - Utilized the Kaggle dataset regarding power system faults
  - Dataset link – <https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset> .
  - Focused on acquiring data that reflects real-world faults occurring in power distribution systems..
- **Data Preprocessing:**
  - Cleaned the dataset to handle missing values, inconsistencies, and outliers in electrical readings..
- **Machine Learning Algorithm:**
  - The Model used is – **Random Forest Classifier** (Based on accuracy and selected the best model).
- **Deployment:**
  - Deployed in Deployment Spaces using the following Model/Algorithm.
  - Used IBM Cloud Object Storage to store and load datasets and artifacts.
- **Evaluation:**
  - Model performance was assessed on unseen fault scenarios.
  - Validate model using accuracy and precision.

# SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the **Power System Fault Detection & Classification** to detect and classify different types of faults in a power distribution system.

- **System requirements**
  - IBM Cloud(mandatory)
  - IBM cloud object storage for dataset handling
  - IBM Watson studio for model development and deployment

# ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**

- We used the Random Forest Classifier, an ensemble learning algorithm that builds multiple decision trees and combines their outputs to improve accuracy and reduce overfitting.
- This algorithm was chosen because the dataset contains structured, labeled data with multiple fault categories and Random Forest excels in multi-class classification tasks. Its ability to handle non-linear relationships, noisy measurements, and feature importance ranking makes it highly suitable for electrical fault classification based on voltage and current phasors.

- **Data Input:**

- Fault Location , Voltage , Current ,Weather condition , Maintenance Status etc..(from features of Dataset).

- **Training Process:**

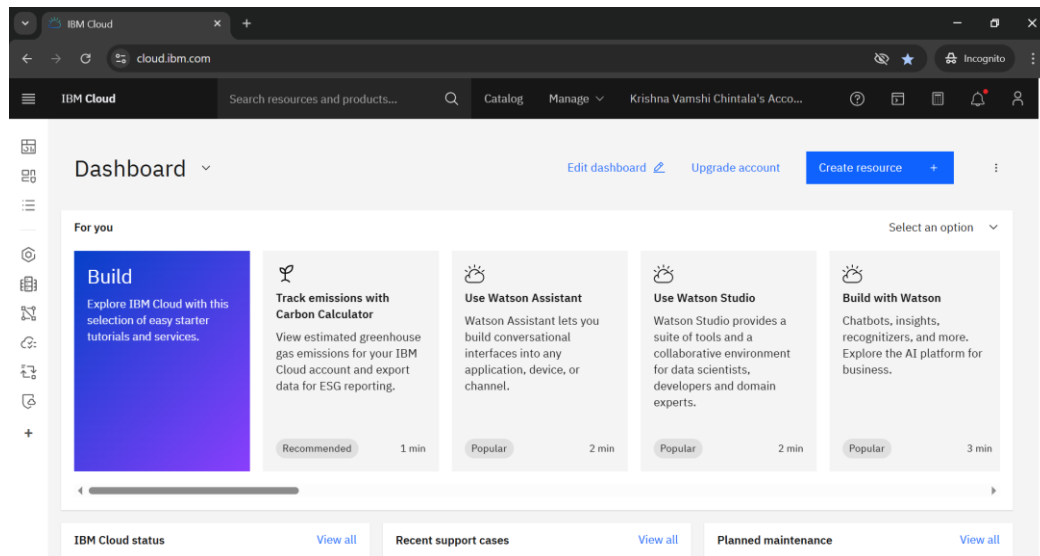
- Supervised Learning Using Labeled Fault types

- **Prediction Process:**

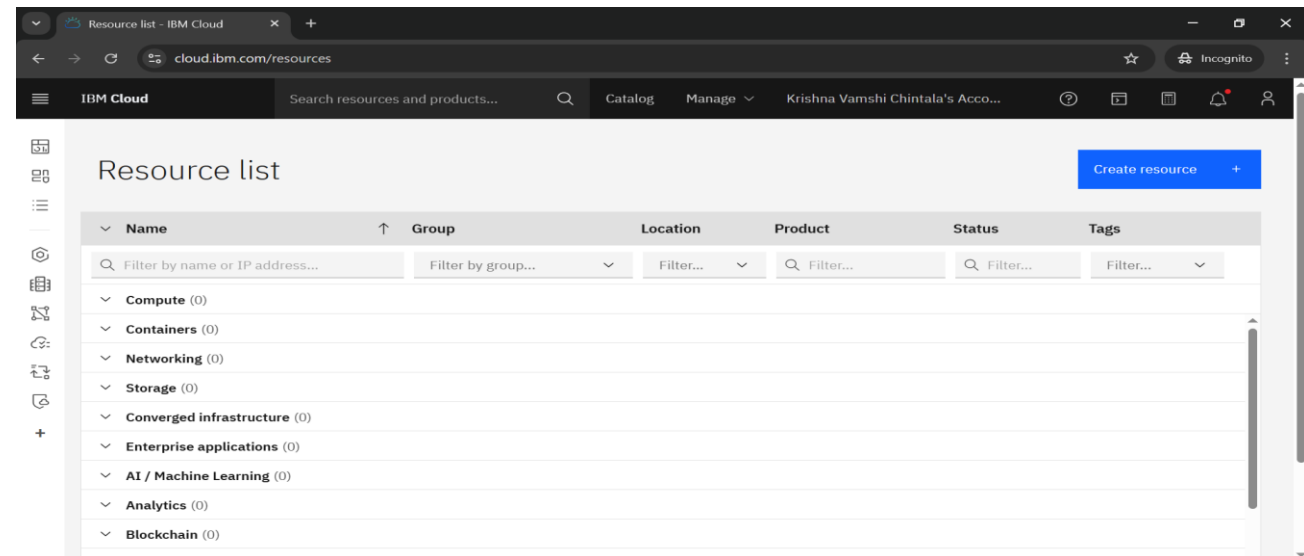
- The Model was deployed on IBM Watson.ai Studio and used Watson.runtime for realtime predictions

# PREDICTION PROCESS

➡ Dashboard of IBM cloud



➡ Verify all resources are empty.



# PREDICTION PROCESS

➡ Create Watsonx.ai studio and manage with Watsonx.runtime

The screenshot shows the 'watsonx.ai Studio' creation page on the IBM Cloud catalog. The page is titled 'watsonx.ai Studio' and includes a description: '(Formerly known as Watson Studio) Develop powerful AI solutions with an integrated collaborative studio and industry-standard APIs and SDKs.' The 'Create' tab is active, showing a 'Select a location' dropdown set to 'Sydney (au-syd)' and a 'Select a pricing plan' section. The pricing plan table shows the 'Lite' plan for 4 authorized users at a price of 'Free'. A 'Summary' sidebar on the right provides details about the service, including its location, plan, and resource group. A 'Create' button is visible at the bottom of the summary sidebar.

Plan	Features and capabilities	Pricing
Lite	4 authorized users	Free

➡ Pipeline for selecting model

The screenshot displays the Watsonx.ai Studio interface for a project named 'Power System Fault Detection'. The 'Progress map' shows a workflow starting with 'Read dataset', followed by 'Split dataset into train and test sets', 'Read training data', 'Preprocessing', 'Model selection', and 'Model evaluation'. The 'Model selection' step is highlighted, showing a 'Relationship map' and a 'Pipeline leaderboard'. The 'Pipeline leaderboard' table lists several pipelines with their respective algorithms, specializations, accuracy, and build times.

Rank	Name	Algorithm	Specialization	Accuracy (Optimized Cross Validation)	Enhancements	Build time
1	Pipeline 9	Enriched Tree Ensemble Classifier (Random Forest Classifier)	ENSE	0.409	WPS-1, PS, WPS-2, BATH	00:01:30
2	Pipeline 5	Random Forest Classifier		0.409	WPS-1, PS, WPS-2	00:01:27
3	Pipeline 4	Step Logistic Regression		0.393	WPS-1, PS, WPS-2	00:00:23
4	Pipeline 3	Step Logistic Regression		0.393	WPS-1, PS	00:00:19
5	Pipeline 7	Random Forest Classifier		0.376	WPS-1, PS	00:01:17
6	Pipeline 6	Random Forest Classifier		0.369	WPS-1	00:00:06



# PREDICTION PROCESS



Deploy in Deployment Spaces and execute for prediction

The screenshot shows the IBM Watson AI Studio interface. The browser address bar displays the URL: `au-syd.dai.cloud.ibm.com/ml-runtime/spaces/488a6aca-4bf8-424f-9647-f041f541f0ef/deployments`. The page title is "ibmfinalproject". The "Deployments" tab is selected, showing a table with one deployment:

Name	Type	Status	Asset	Asset type	Tags	Last modified
fault_deployment	Online	Deployed	P9 - Random Forest Classifier: Power System Fault Detection	Model		1 minute ago Krishna Vamshi Chintala (You)

At the bottom, it indicates "Items per page: 20" and "1-1 of 1 items".



Deploy in Deployment Spaces and Test for test cases of model prediction

The screenshot shows the IBM Watson AI Studio interface for testing a deployment. The browser address bar displays the URL: `au-syd.dai.cloud.ibm.com/ml-runtime/deployments/98e4744c-2a02-427d-b6c2-a21d0b99c24a?space_id=488a6aca-4bf8-424f-9647-f041f...`. The page title is "fault\_deployment". The "Test" tab is selected, showing the "Endpoints for scoring" section. The "Private endpoint" is highlighted, and the "Bearer token" is set to "IAM". The "Public endpoint" is also visible. The "Code snippets" section shows a cURL command for testing the model.

**Endpoints for scoring**

Private endpoint: `https://private.au-syd.ml.cloud.ibm.com/ml/v4/deployments/98e4744c-2a02-427d-b6c2-a21d0b99c24a/predictions`

Public endpoint: `https://au-syd.ml.cloud.ibm.com/ml/v4/deployments/98e4744c-2a02-427d-b6c2-a21d0b99c24a/predictions?version=...`

**Code snippets**

cURL

```
# NOTE: you must set SAPI_KEY below using information retrieved from your IBM Cloud account (https://au-syd.dai.cloud.ibm.com/docs/content/wai/an...
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" \
```

# RESULT

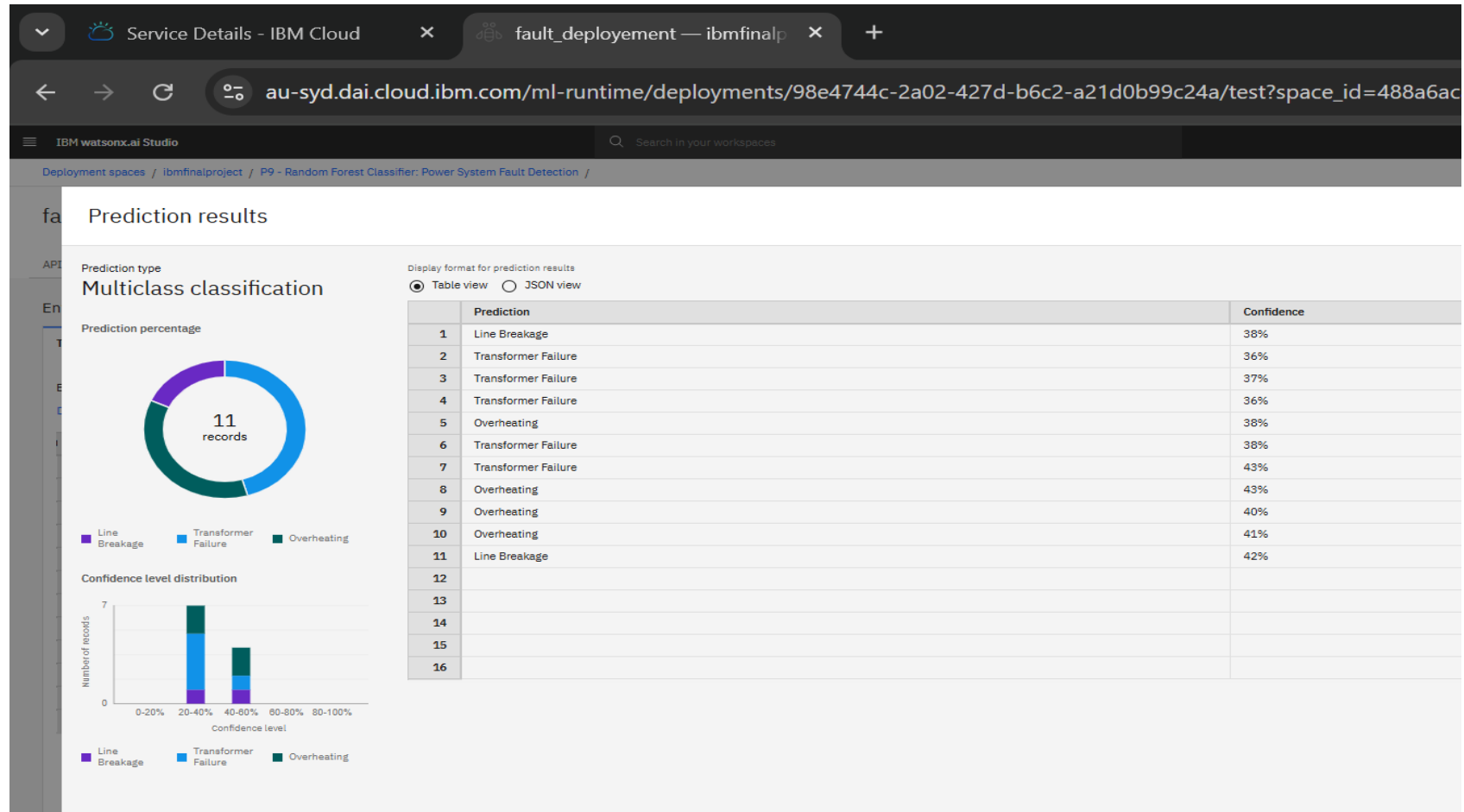
➡ INPUT : Testing data given as input

The screenshot shows the IBM Watson AI Studio interface. The top navigation bar includes the IBM logo, a search bar, and user information. The main content area displays the 'fault\_deployment' model, which is 'Deployed' and 'Online'. Below this, the 'Test' tab is selected, showing a table of input data. The table has 8 columns: Temperature (°C) (double), Wind Speed (km/h) (double), Weather Condition (other), Maintenance Status (other), Component Health (other), Duration of Fault (hrs) (double), and Down time (hrs) (double). The table contains 6 rows of data. A 'Predict' button is visible at the bottom right of the table.

	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	31	24	Rainy	Scheduled	Normal	4	6.2
2	35	15	Rainy	Completed	Normal	4.6	3.3
3	27	14	Clear	Completed	Overheated	4.8	1.9
4	34	17	Rainy	Completed	Faulty	4.4	5.6
5	39	22	Windstorm	Completed	Overheated	3.8	6.7
6	29	22	Thunderstorm	Scheduled	Normal	2.4	5

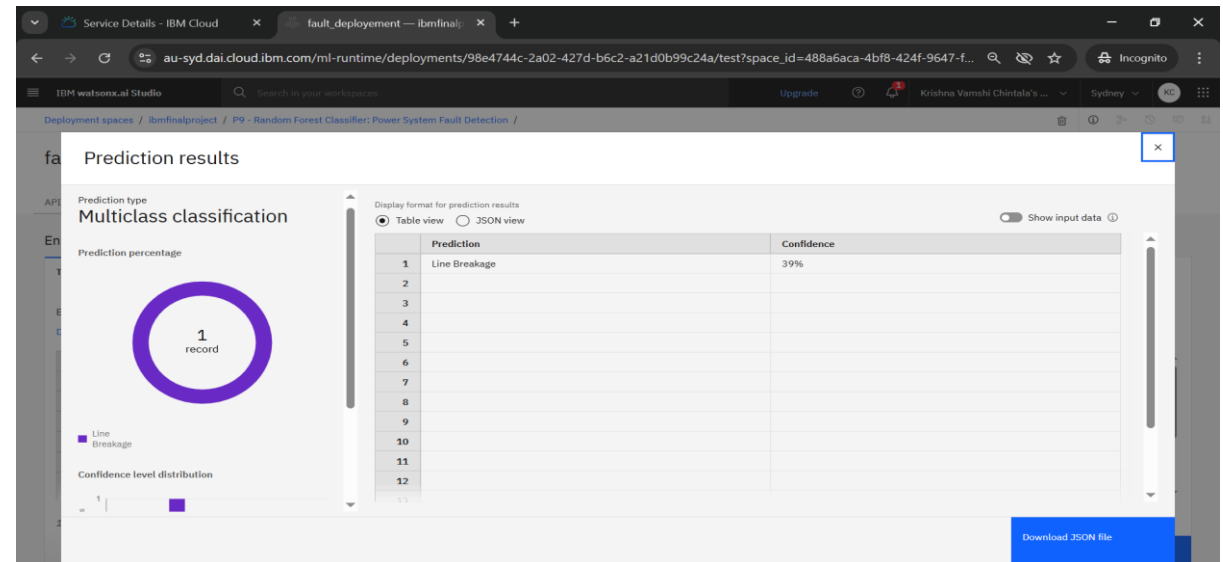
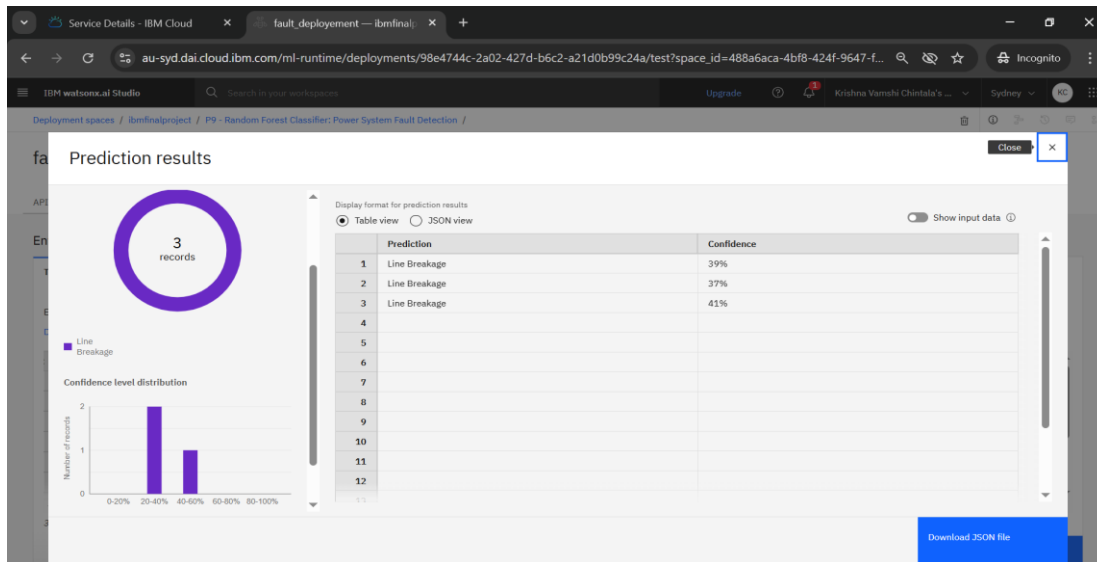
# RESULT

➡ Prediction Result



# RESULT

➡ Test Cases



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# CONCLUSION

- This project successfully demonstrates an effective ML-based solution for detecting and classifying power system faults.
- The integration with IBM Cloud allows for scalable, cloud-based deployment for real-time fault monitoring in smart grids.

# FUTURE SCOPE

## **Further Enhancement can be :**

- Include real-time streaming data using edge devices or IoT sensors
- Extend the model to cover high-voltage transmission faults
- Integrate advanced deep learning models (e.g., LSTM for time-series phasors)
- Visual dashboard with alerting system for control rooms

# REFERENCES

- <https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset>
- IBM Cloud & Watsonx.ai Documentation
- Research papers on ML for power fault classification

In recognition of the commitment to achieve  
professional excellence



# KRISHNA VAMSHI CHINTALA

Has successfully satisfied the requirements for:

## Getting Started with Artificial Intelligence



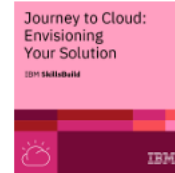
Issued on: Jul 21, 2025  
Issued by: IBM SkillsBuild

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Has successfully satisfied the requirements for:

## Journey to Cloud: Envisioning Your Solution



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According to the Adobe Learning Manager system of record

**Completion date:** 24 Jul 2025 (GMT)

**Learning hours:** 20 mins



# THANK YOU