CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING ML

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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**

PROBLEM STATEMENT

Example: Power distribution systems are prone to various types of faults such as line-to-ground, line-to-line, and three-phase faults. These faults can disrupt power supply and reduce system reliability. The challenge lies in accurately detecting and classifying these faults using electrical measurement data (voltage, current, phasors) to differentiate them from normal operating conditions, thereby ensuring the stability of the power grid.

PROPOSED SOLUTION

- **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.**
- **Key Components**
- **Data Collection:**
  - **Use the Kaggle dataset on power system faults.**
- **Data Preprocessing:**
  - **Clean and normalize the dataset.**
- **Machine Learning Algorithm:**
  - **Train a classification model e.g : Decision Tree, Random Forest, or SVM**
- **Deployment:**
  - **Develop a user-friendly interface or application that provides to known real-time predictions for different types of fault detections.**
- **Evaluation:**
  - **Validate the model using Fault ID,Fault Location,Voltage,current, accuracy, Power Load,Temparature,Wind Speed,Weather,precision, recall, and F1-score.**

SYSTEM APPROACH

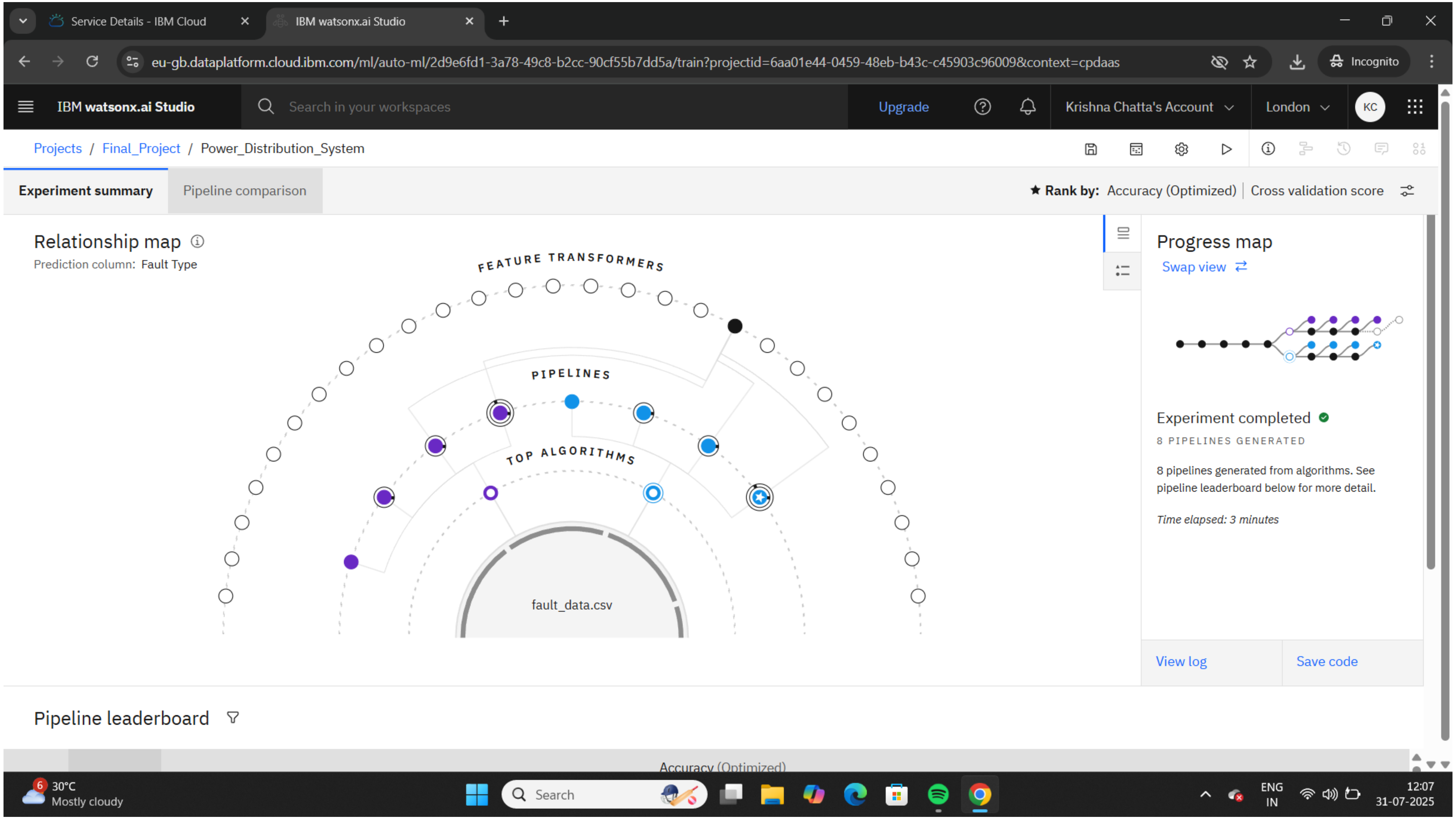
The "System Approach" section outlines the overall strategy and methodology for developing and implementing the power system fault detection and classification. Here's a suggested structure for this section:

- System requirements:
- IBM Cloud
- IBM Watson studio for model development and deployment
- IBM cloud object storage for dataset handling

ALGORITHM & DEPLOYMENT

- In the Algorithm section, describe the machine learning algorithm chosen for predicting Fault type. Here's an example structure for this section:
- **Algorithm Selection:**
  - Random Forest Classifier (or SVM based on performance)
- **Data Input:**
  - Voltage, current, and phasor measurements from the dataset
- **Training Process:**
  - Supervised learning using labeled fault types
- **Prediction Process:**
  - Model deployed on IBM Watson Studio with API endpoint for real-time predictions

RESULT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Projects / Final_Project / Power_Distribution_System
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
fault_data.csv
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
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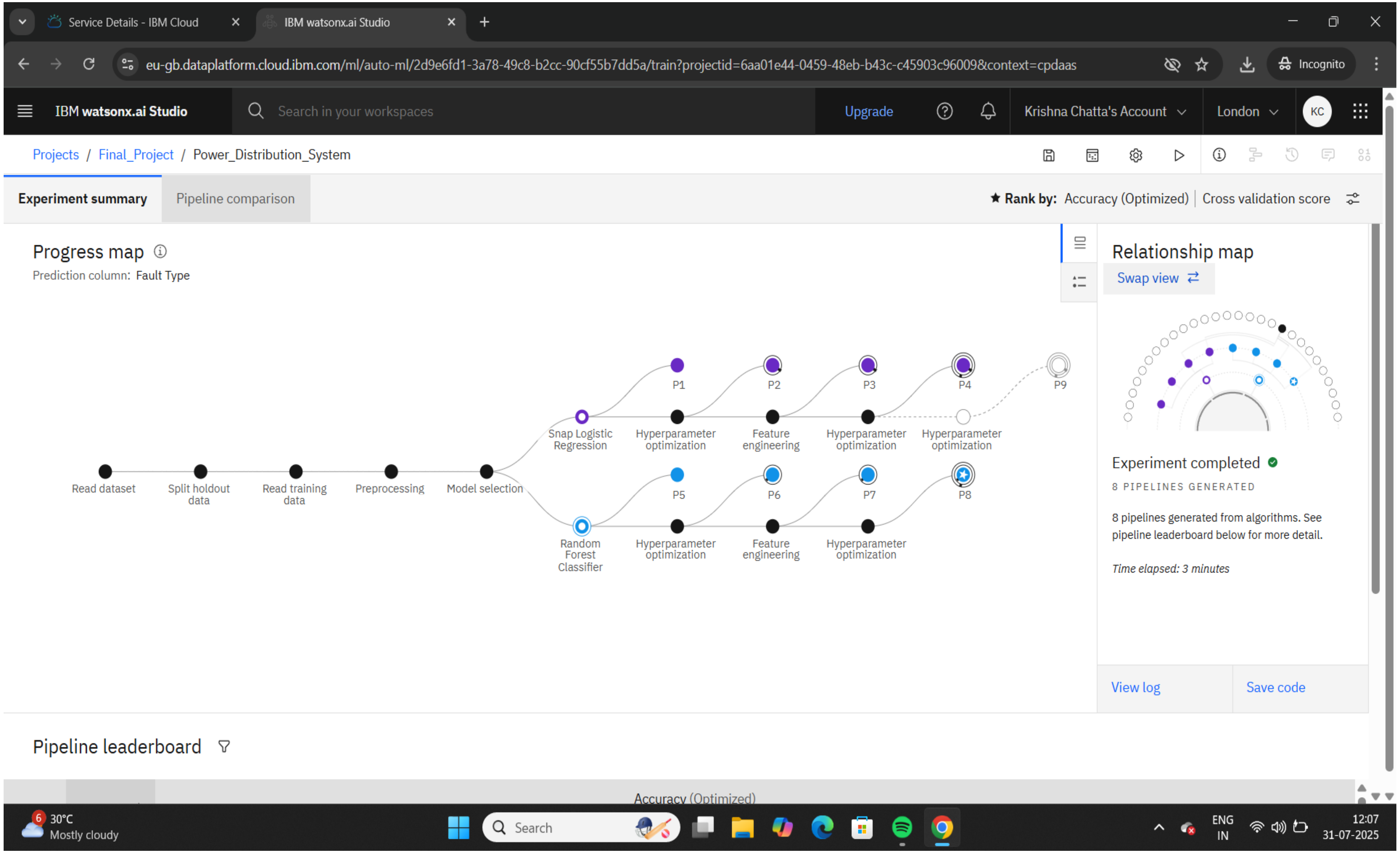
RESULT



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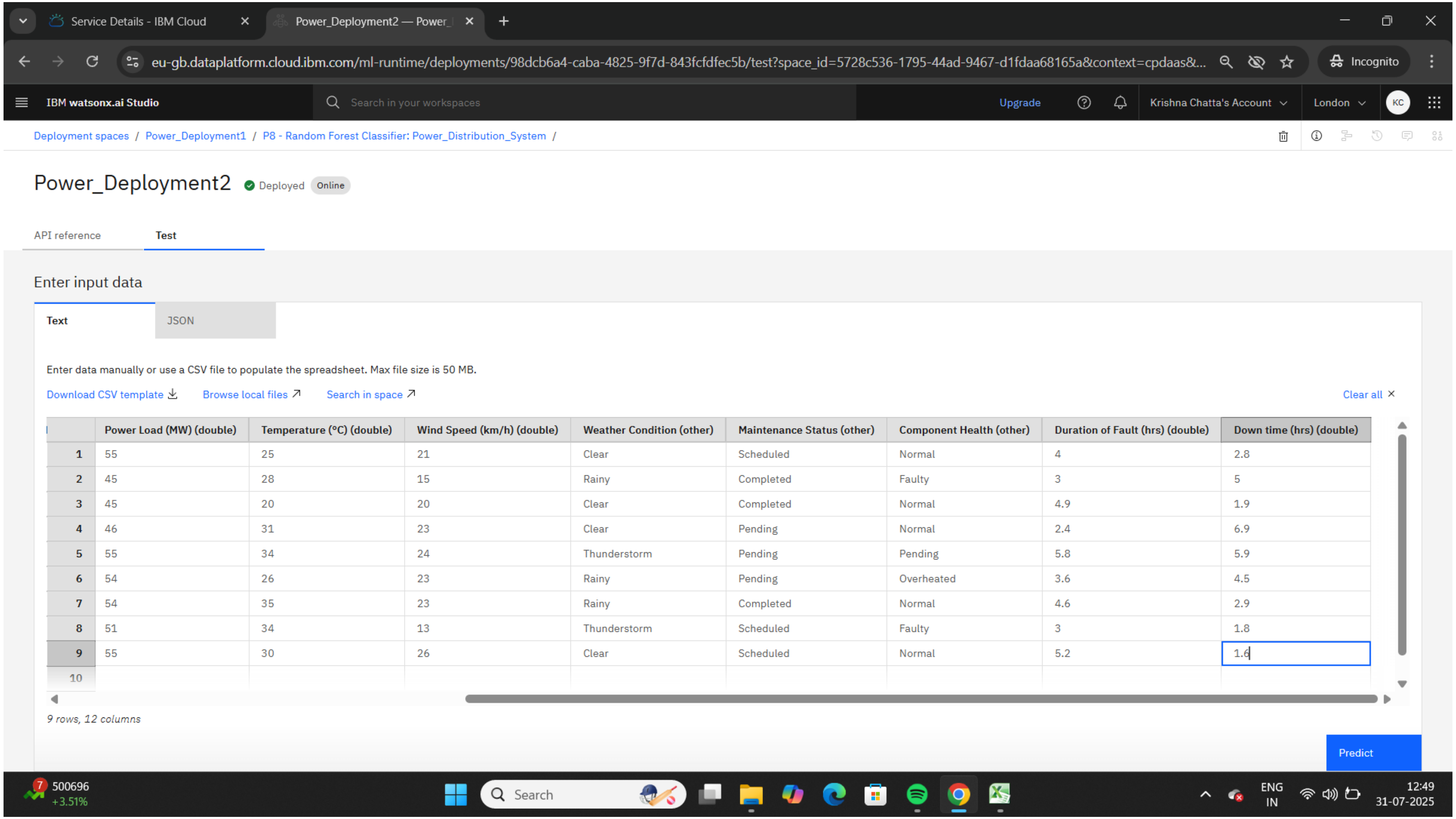
RESULT



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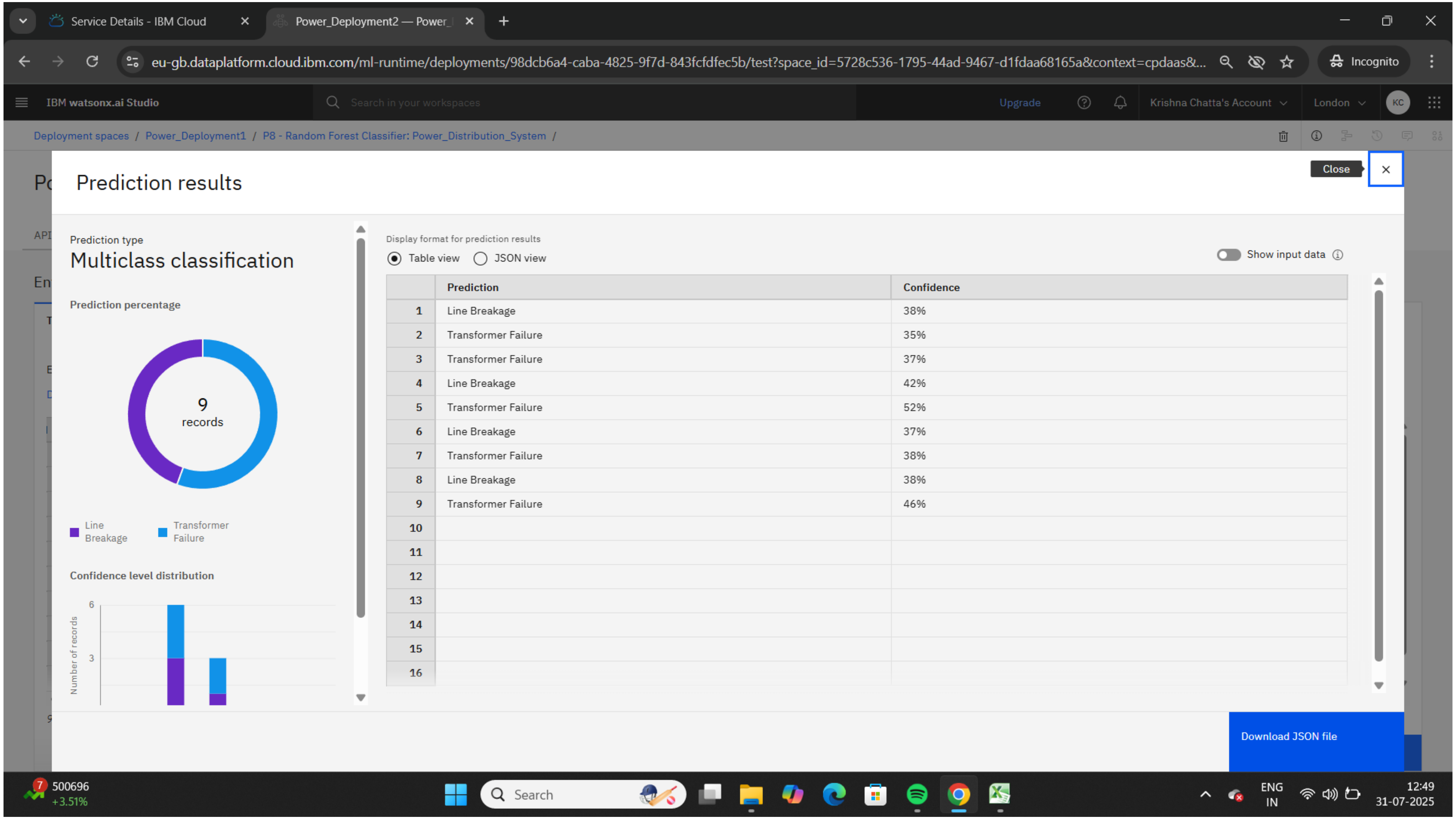

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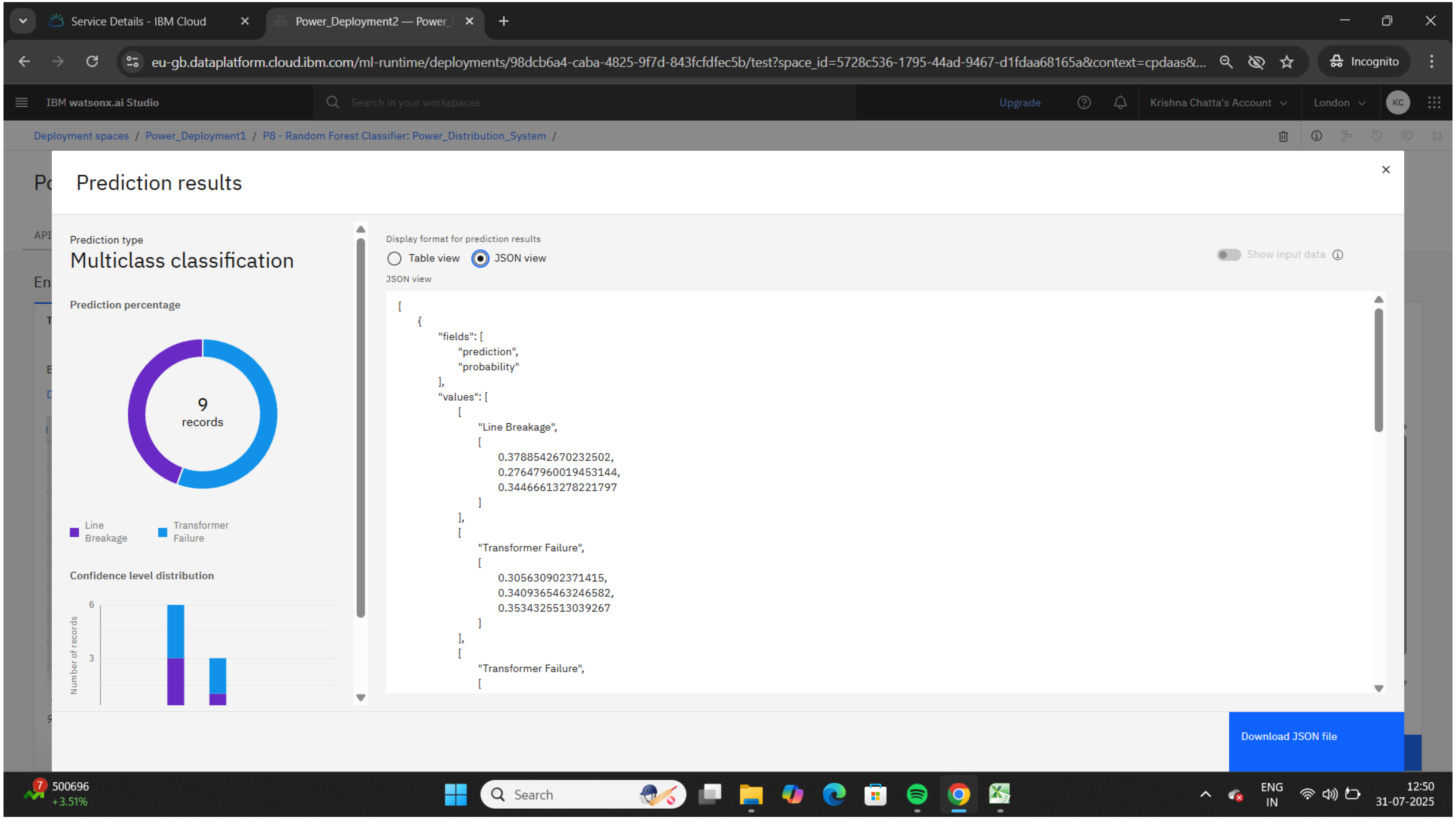
RESULT


Service Details - IBM Cloud
Power_Deployment2 — Power_
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Deployment spaces / Power_Deployment1 / P8 - Random Forest Classifier: Power_Distribution_System /
Prediction results
Prediction type
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Prediction percentage
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Display format for prediction results
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CONCLUSION

- The machine learning-based model developed for Power System Fault Detection and Classification offers a robust and efficient method for detecting and classifying various fault types in power distribution systems. By leveraging electrical measurement data such as voltage and current phasors, the model can effectively distinguish between normal operations and faults like line-to-ground, line-to-line, and three-phase faults. This contributes significantly to improving the reliability, safety, and efficiency of power grid operations. Furthermore, the use of IBM Cloud Lite services demonstrates the practical deployment of AI solutions in cloud-based environments

FUTURE SCOPE

- Real-Time Fault Prediction: Integrate the model with real-time SCADA systems to allow live fault prediction and response.
- Expanded Fault Categories: Extend the model to cover more complex or rare fault types and disturbances (e.g., harmonics, transients).
- Smart Grid Integration: Embed the model into smart grid infrastructure for self-healing capabilities and enhanced automation.
- Edge Deployment: Deploy lightweight versions of the model on edge devices for faster, localized decision-making.
- Model Generalization: Improve generalization across different geographic regions and grid topologies using transfer learning or federated learning.
- Cybersecurity Monitoring: Enhance the system to detect anomalies not only due to physical faults but also cyber-attacks on the grid.

REFERENCES

- ## Dataset:
- Kaggle Dataset: Power System Faults Dataset.
- ## Technologies Used:
- IBM Cloud Lite Services – For cloud-based model development and deployment.
- ## Related Research Papers:
- “Fault detection, classification and location using wavelet transform,” Electric Power Systems Research, 2009.
- “Artificial neural network approach for fault classification and location,” IEEE Transactions on Power Delivery, 2005.
- ## ML Concepts:
- Use of time-series data preprocessing and supervised learning techniques (e.g., Random Forest, SVM, CNN).

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Lab: Retrieval Augmented Generation with LangChain

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Completion date: 24 Jul 2025 (GMT) **Learning hours:** 20 mins

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