CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION

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OUTLINE

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PROBLEM STATEMENT

- Despite advancements in power system monitoring, there is no widely adopted intelligent solution that can accurately and rapidly detect and classify all types of faults (e.g., line-to-ground, line-to-line, three-phase) in power distribution systems using real-time electrical measurements.
- Existing methods rely heavily on manual inspection or fixed threshold-based techniques, which are often inaccurate, slow, and not scalable. This lack of an intelligent, data-driven fault diagnosis system poses a major risk to grid stability and reliability.

PROPOSED SOLUTION

- The proposed system aims to address the challenge of detecting and classifying faults in power distribution systems to ensure quick response and grid stability. This involves leveraging electrical measurement data and machine learning techniques to identify fault types accurately and in real-time. The solution will consist of the following components.

- **Data Collection:**
  - Gather historical and real-time data including voltage and current phasors from sensors or PMUs.
  - Incorporate external metadata such as fault location, timestamp, and fault type labels for training.
- **Data Preprocessing:**
  - Clean and preprocess data to handle noise, missing values, and inconsistencies.
  - Apply feature engineering to extract critical features like voltage drops, phase imbalances, and frequency deviation.

- **Machine Learning Algorithm:**
  - Use classification models such as Random Forest, SVM, or LSTM to detect and classify fault types.
- **Deployment:**
  - Develop a real-time monitoring dashboard showing detected faults and their locations.
  - Deploy the model on edge or cloud platforms ensuring scalability and low-latency response.
- **Evaluation:**
  - Evaluate the model using accuracy, precision, recall, F1-score, and confusion matrix.
  - Continuously monitor performance and fine-tune based on live data and expert feedback.
- **Result:**
  - A smart, real-time fault detection system that enhances power grid reliability, safety, and fault response speed.

SYSTEM APPROACH

- In this project, IBM Watsonx . ai was used to create and deploy a model for detecting power system faults.

System requirements:

- Watsonx . ai Studio – for training the model.
- Watsonx Runtime – for deploying the model and getting real- time predictions.
- IBM Cloud Object Storage – for storing and accessing the dataset.
- Dataset with voltage, current, power factor, and frequency values labeled with fault types.

Services Used:

- AutoAI – handled data processing, feature selection, and chose Snap Logistic Regression for classification.
- Watsonx Runtime – hosted the model and generated REST APIs for predictions.
- Cloud Object Storage – managed the dataset securely.

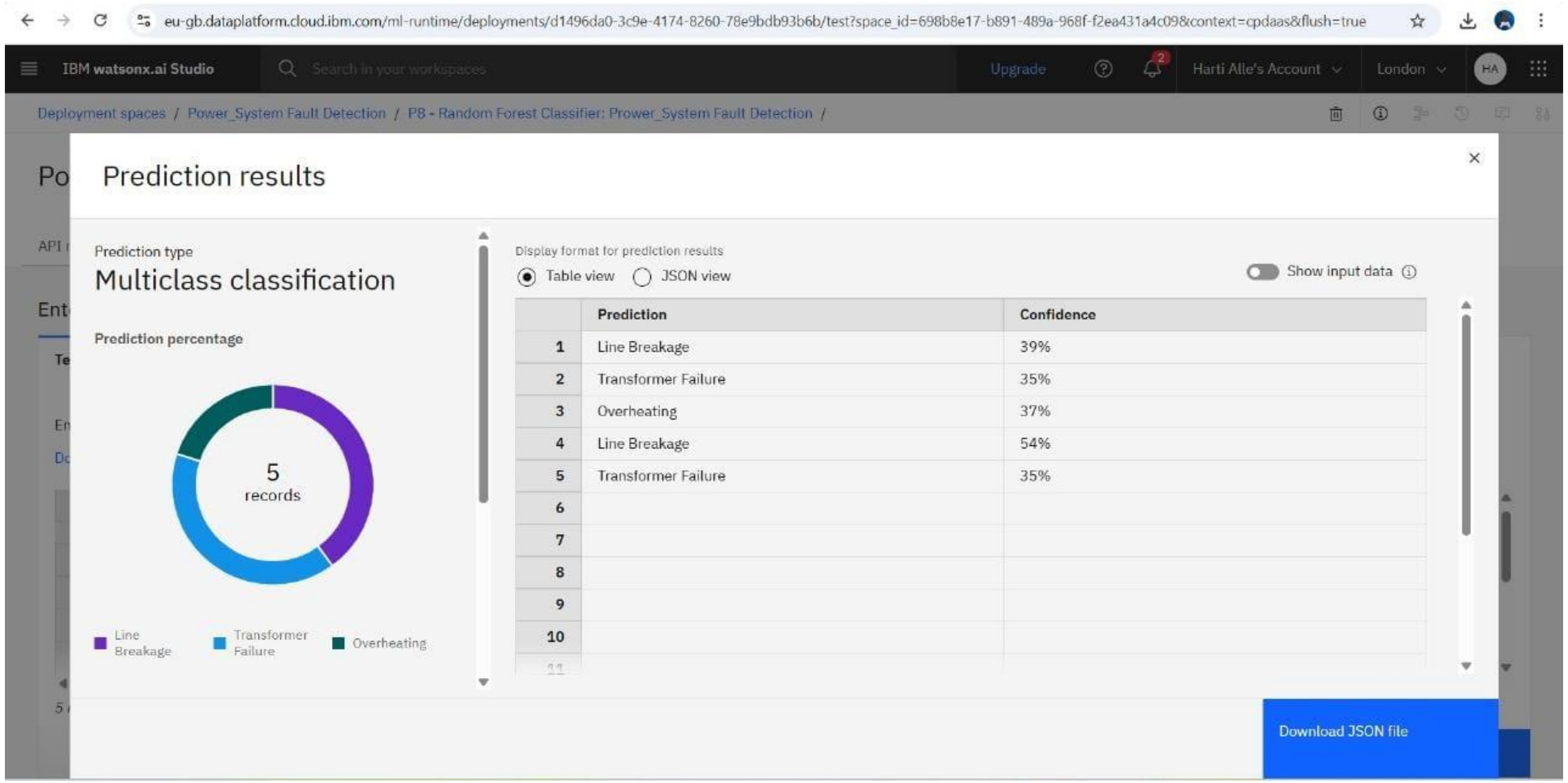
ALGORITHM & DEPLOYMENT

- In the Algorithm section, describe the machine learning algorithm chosen for predicting fault types.

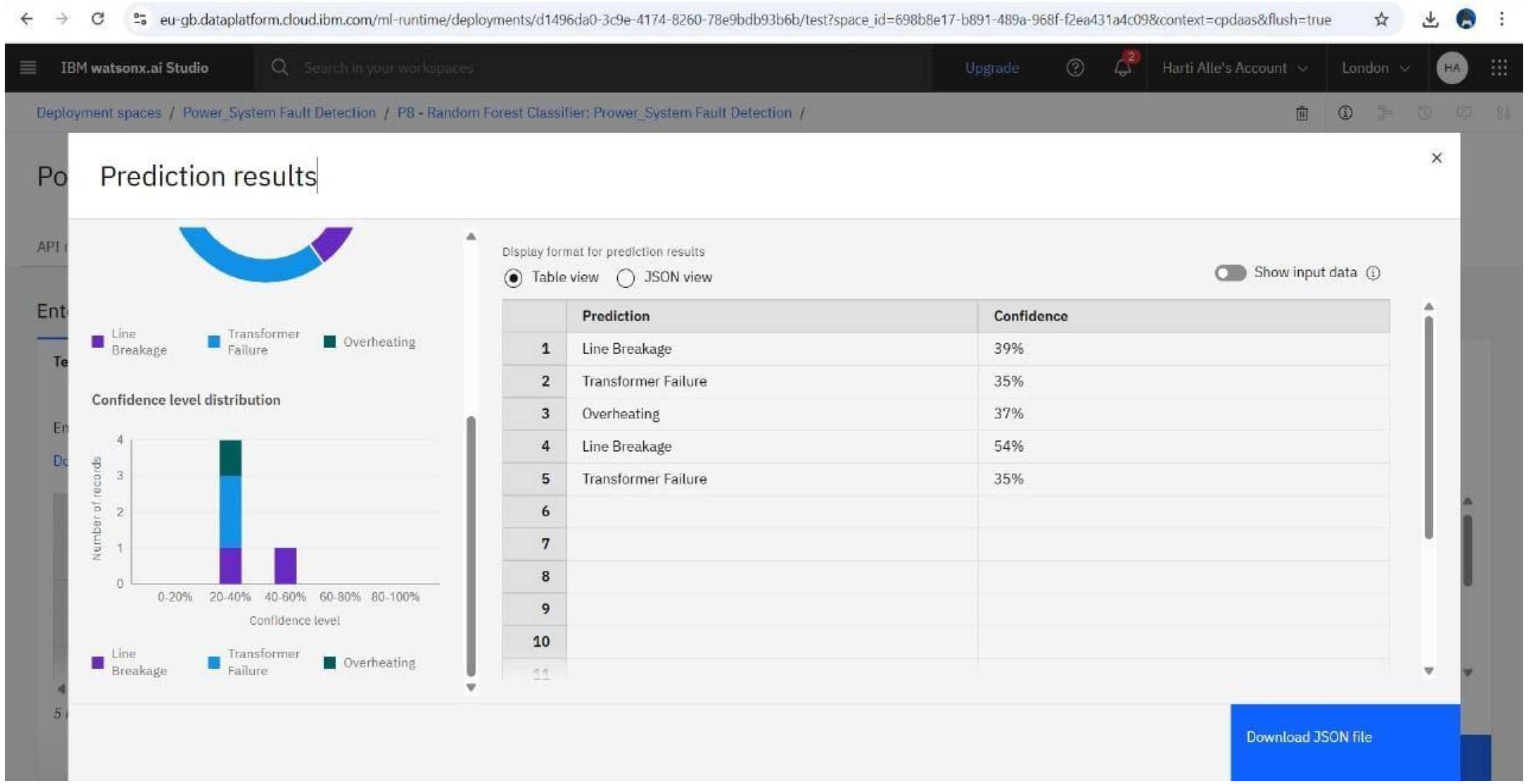
- **Algorithm Selection:**
  - Snap Logistic Regression implemented in IBM Watsonx.ai Studio, selected for its speed, scalability, and accuracy in multiclass fault classification (e.g., line - to - ground, line - to - line, overheating) .
- **Data Input:**
  - Processed real - time electrical signals including: Voltage, current, power factor, frequency, Labelled fault classes for supervised learning. Dataset stored and accessed via IBM Cloud Object Storage.
- **Training Process:**
  - Model trained using AutoAI pipelines with built - in data preprocessing and cross validation.
  - Optimized for classification accuracy using historical fault records .
- **Prediction Process:**
  - Model deployed on IBM Cloud with REST API endpoint.
  - Supports real - time predictions with confidence scoring, enabling smart and fast fault detection.

RESULT

❖ **Multiclass output with 5 Records Prediction:**



❖ Multiple Faults detection(Line Breakage(39%) and Overheating(37%) and Transfarmer Failure(35%)) :



CONCLUSION

- The project successfully demonstrates the application of machine learning in enhancing power system reliability through efficient fault detection and classification . By leveraging real - time electrical measurements and cloud - based deployment on IBM Watsonx, the system provides a scalable, accurate, and intelligent solution for identifying critical fault types . This approach not only improves operational efficiency but also contributes to the stability and resilience of modern power grids .

FUTURE SCOPE

- Improve accuracy by testing advanced ML algorithms.
- Enable real-time fault detection and alerts.
- Add fault location tracking feature.
- Scale the system for large and complex power grids.
- Integrate with IoT devices and smart meters.
- Make the system self-learning with new data.
- Extend to handle more types of faults and conditions.

REFERENCES

- We Have used Kaggle Dataset for Power System Fault Detection and Machine Learning Model.
- Kaggle Dataset: https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset
- Training class by Edunet Foundation.

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THANK YOU

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