CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION

Presented By:
1. S.Shravani- Jyothishmathi Institute of Technology and Science - Computer Science and Engineering

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OUTLINE

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PROBLEM STATEMENT

Power systems often experience faults such as line-to-ground, line-to-line, and three-phase faults, which can lead to instability and outages. Despite advancements in monitoring, accurately identifying and classifying these faults in real-time remains a challenge due to overlapping signals and complex electrical patterns. This issue affects the reliability and stability of power distribution networks.

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:**
  - Upload structured dataset (voltage, current, power factor, frequency, and fault type labels) to IBM Cloud Object Storage. Utilize labeled data representing different fault scenarios (e.g., Line Breakage, Overheating).
- **Data Preprocessing:**
  - Automatically handled by Watsonx.ai AutoAI, which:
  - Cleans and processes data to manage noise, missing values, and inconsistencies.
  - Performs automated feature engineering to identify patterns relevant to fault classification.

Machine Learning Algorithm:

- Snap Logistic Regression selected by AutoAI for efficient multiclass classification.
- Model built entirely through Watsonx.ai Studio without manual coding.
- **Deployment:**
- Model deployed using Watsonx Runtime.
- Real-time fault predictions accessed via REST API endpoints,
- providing fault type and confidence scores.
- **Evaluation:**
- AutoAI provides performance metrics (accuracy, precision, recall, F1-score).
- Model can be retrained or fine-tuned with new data for improved reliability.
- **Result:**
- cloud-based, no-code intelligent fault detection system that enhances grid reliability, safety and fault response speed using IBM Watsonx.ai services.

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
- BM 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

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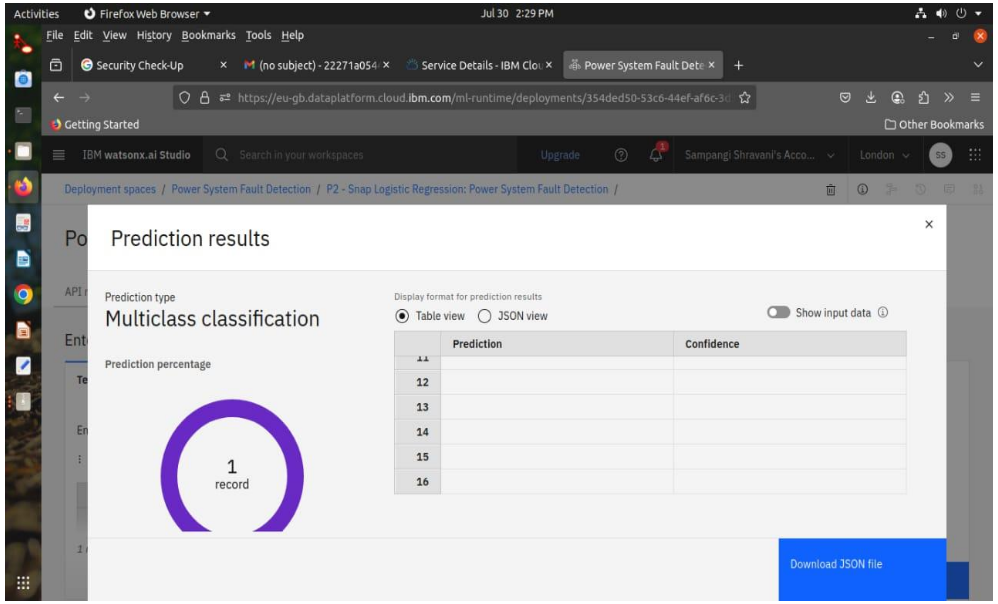
ALGORITHM & DEPLOYMENT

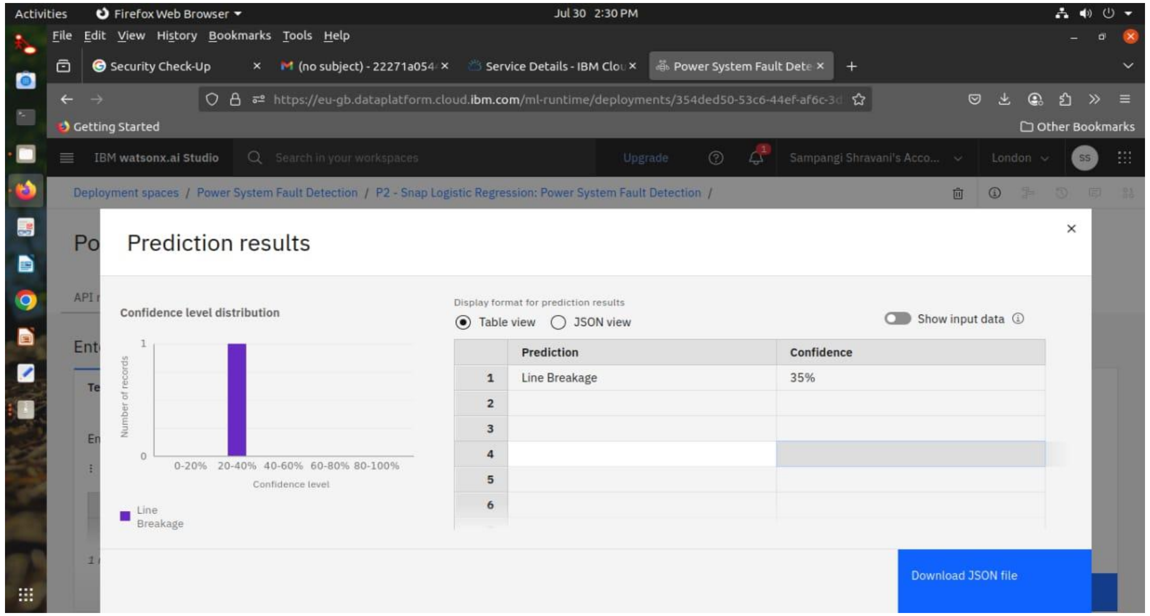
- In the Algorithm section, describe the machine learning algorithm chosen for predicting fault types. Here's an example structure for this section:
- **Algorithm Selection:**
  - Snap Logistic Regression implemented in IBM Watsonx.ai Studio, selected for its speed, scalability, and accuracy in multiclass 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

A) Multiclass output with 1 record detected

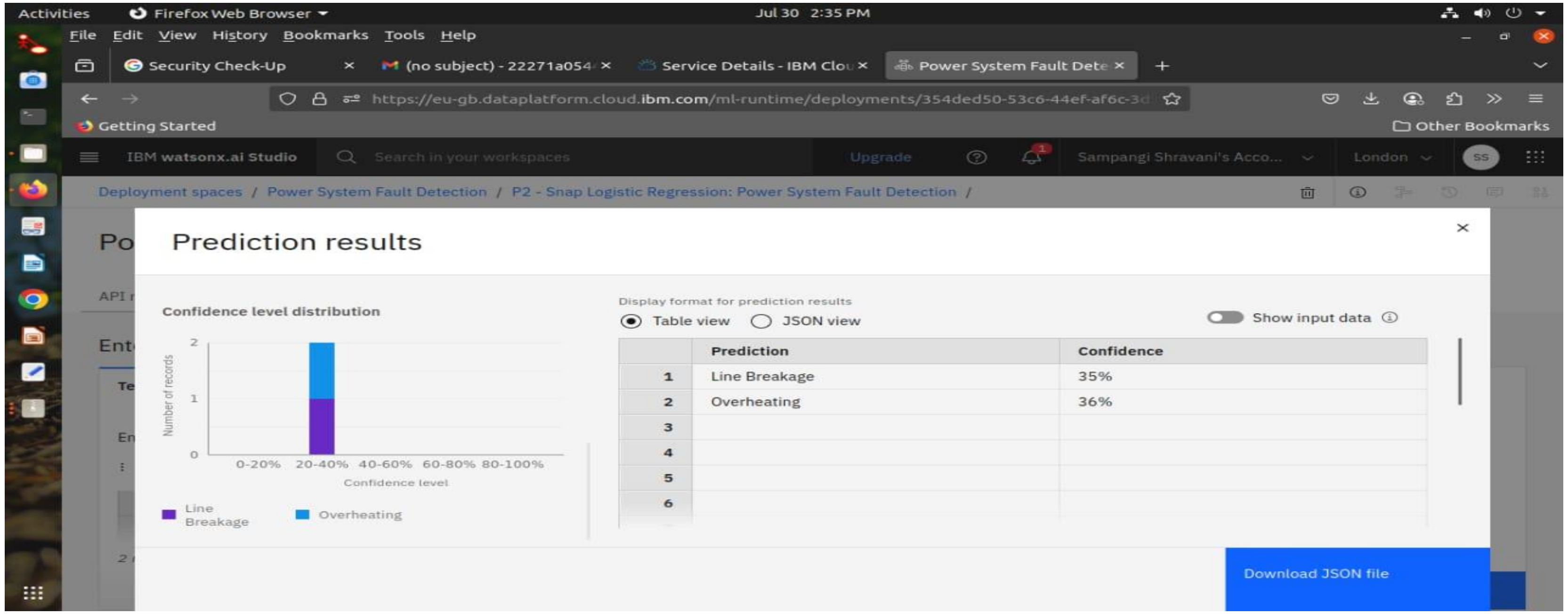


B) Line Breakage predicted with 35% confidence



The model performed multiclass classification to detect power system faults. It predicted Line Breakage with 35% confidence, indicating its capability to identify specific fault type

MULTI-FAULT CLASSIFICATION OUTPUT



- The model identified simultaneous faults in the power system, predicting Line Breakage (35%) and Overheating (36%). This demonstrates the model's capability to perform multi-fault classification with confidence-based insights.

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

- Explore potential improvements to enhance the system's effectiveness. This includes integrating real-time data from advanced sensors, improving model accuracy with robust algorithms, and expanding the system to handle more fault types. Future developments may also involve deployment on large-scale smart grids and incorporating intelligent alert mechanisms for quicker response and maintenance..

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 classes by Edunet Foundation.

IBM CERTIFICATIONS

- credly certificate(getting started with AI)

IBM CERTIFICATIONS

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THANK YOU