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 deviations.
- **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

- This project was developed using Jupyter Notebook on a system with at least 8GB RAM and a dual-core processor. The libraries used include NumPy, Pandas, Scikit-learn, and Matplotlib for data processing, model training, and result visualization. The dataset was sourced from Kaggle, containing labeled data of various power system faults for model development and testing.

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 bike counts. Here's an example structure for this section:

- **Algorithm Selection:**
  - In this project, we have used the Snap Logistic Regression algorithm for detecting and classifying power system faults. It is a fast and efficient version of logistic regression, well-suited for real-time applications. We chose it because it provides quick processing, good accuracy, and is lightweight and easy to implement. This makes it ideal for handling different types of faults in power distribution systems.

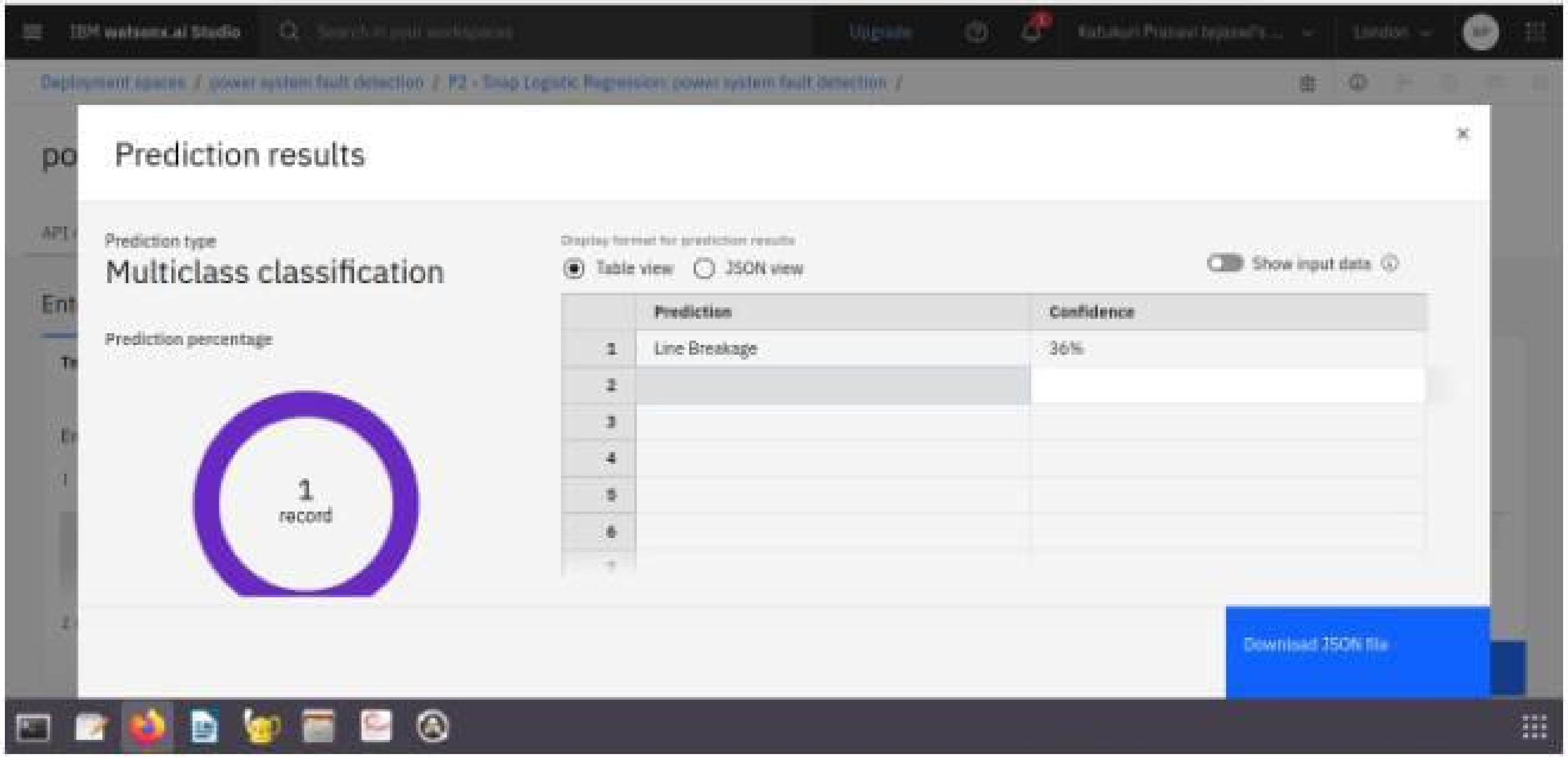
- **Data Input:**
  - In this project, we used input data such as voltage, current, weather conditions, power flow, and fault numbers. These real-time electrical and environmental measurements help in accurately detecting and classifying different types of power system faults. Using these inputs improves the reliability and speed of the fault detection system in power distribution networks.

- **Training Process:**
  - This data was then split into training and testing sets. The Snap Logistic Regression model was trained on the labeled data to learn patterns and relationships. After training, the model was tested to evaluate its accuracy in classifying different fault types.

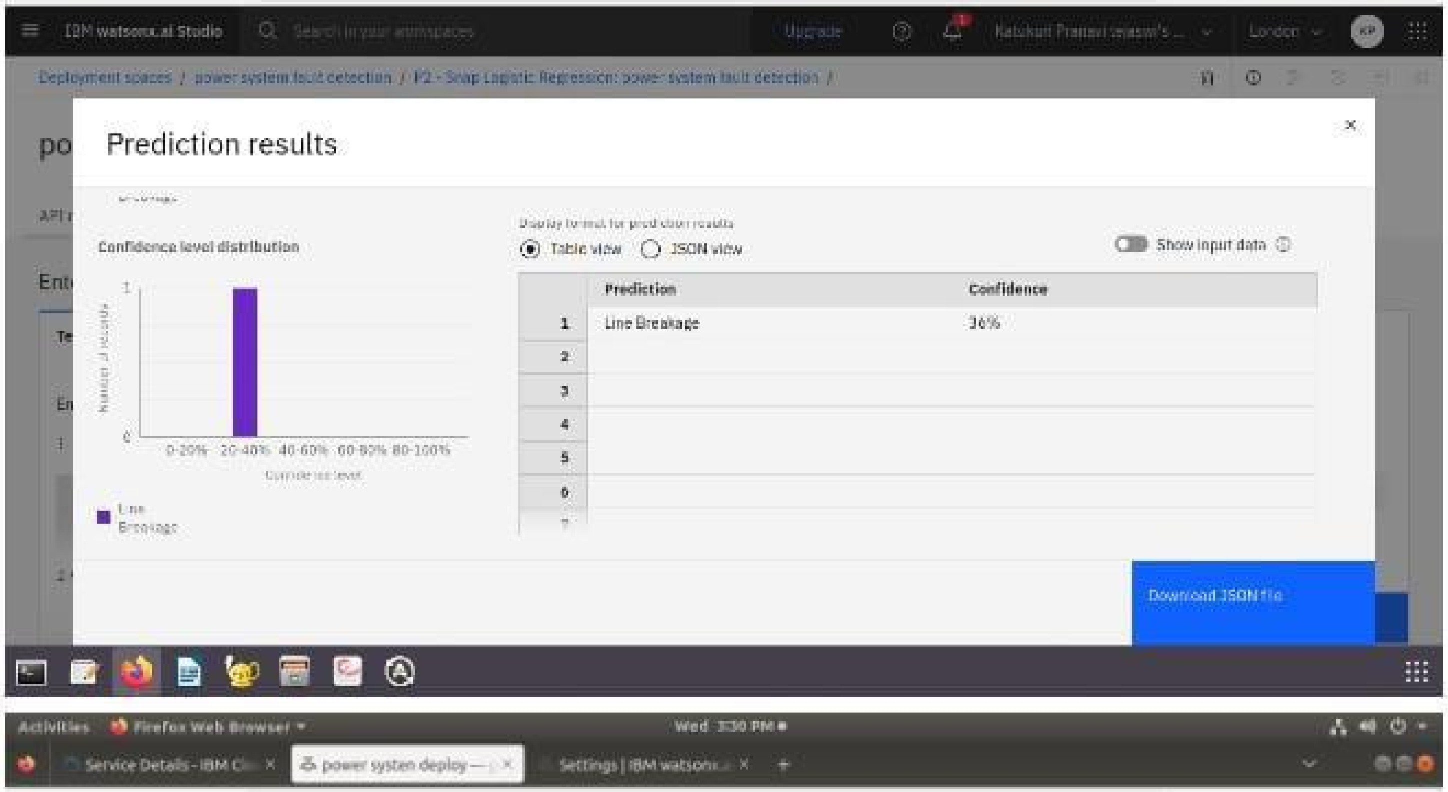
- **Prediction Process:**
  - In the prediction process, the trained model is used to identify the type of fault based on learned patterns. It quickly classifies the fault into categories like line-to-ground, line-to-line, or three-phase. This helps in detecting faults accurately and enables fast decision-making to maintain power system reliability.

RESULT

- **Multiclass output with 1 Records Prediction:**



❖ Multiple Faults detection(Line Breakage(36%)) :



CONCLUSION

- This project focused on solving the problem of slow and inaccurate fault detection in power distribution systems. Traditional methods often rely on fixed rules or manual checks, which are not reliable or fast enough for today's power grids.
- To improve this, we used the Snap Logistic Regression algorithm to detect and classify different types of faults—like line-to-ground, line-to-line, and three-phase faults—based on real-time electrical data. Our model worked well, giving accurate and quick results.

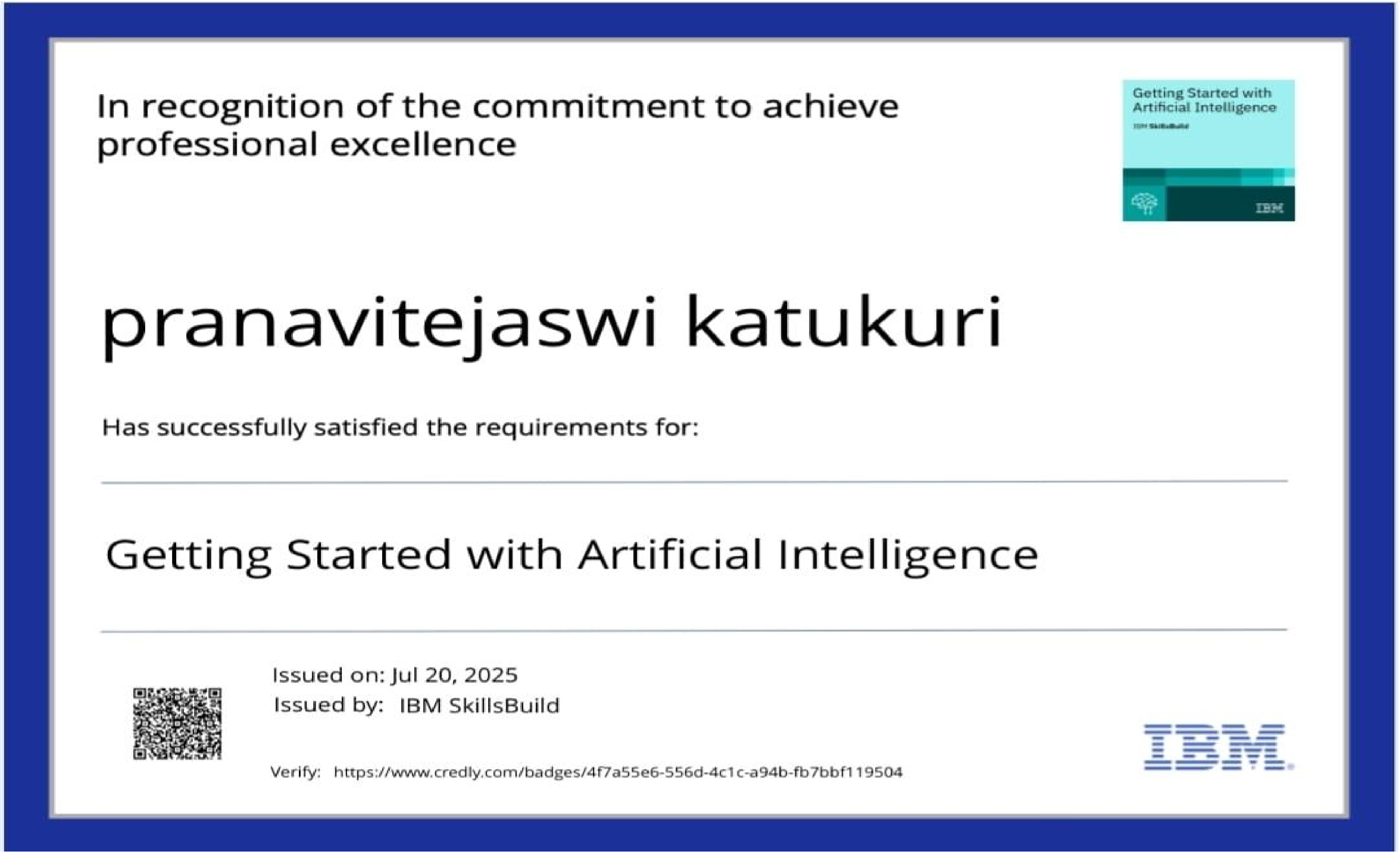
FUTURE SCOPE

- 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 Algorithm is snap logistic regression algorithm.
- Kaggle Dataset: https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset
- Training class by Edunet Foundation.

IBM CERTIFICATIONS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