CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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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

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 address the challenge of enabling rapid and accurate identification of electrical faults in a power distribution system using machine learning. This includes leveraging IBM Watsonx Agentic AI to classify fault types from electrical parameters such as voltage and current. The solution will consist of the following components:
- Data Collection:
  Collect electrical measurement data such as voltage magnitude, current magnitude, and power load from the Kaggle dataset.
  Include simulated fault cases such as Line-to-Ground (LG), Line-to-Line (LL), and Three-Phase faults.
- Data Preprocessing:
  Clean and normalize the raw voltage and current readings.
  Encode categorical features like weather and component health.
  Split the data into training and testing sets for model development.
- Agentic AI Model:
  Use IBM Watsonx.ai's Agentic workflow with foundation models (e.g., Granite or Mistral).
  Enable interactive fault classification queries like "What type of fault is occurring with this voltage and current data?"
- Deployment:
  Build and deploy the agent using Watsonx Agentic Lab (free sandbox project).
  Associate Watsonx.ai Runtime with the project and set up prompt flows.
  Enable tools for real-time inference and decision-making.
- Evaluation:
  Test the model's fault classification accuracy using metrics like accuracy, F1-score, and confusion matrix.
  Evaluate the agent's responses for correctness, speed, and usability.
- Result:
  Outputs include fault type predictions (e.g., LG, LLG, LLLG) with corresponding confidence levels.
  Interactive agent demo on IBM Cloud responding to user fault queries with reasoning.

SYSTEM APPROACH

- **System Requirements:**
- IBM Cloud Lite account
- Watsonx.ai Runtime
- Agentic AI Lab interface
- **Libraries & Tools:**
- Watsonx.ai GUI
- IBM Granite Foundation Model
- Agentic Workflow Editor

ALGORITHM & DEPLOYMENT

- **Model Used:**

  Random Forest Classifier (or suitable ML model for classification)
- **Foundation Model:**

  IBM Granite Foundation Model via Watsonx.ai
- **Inputs:**

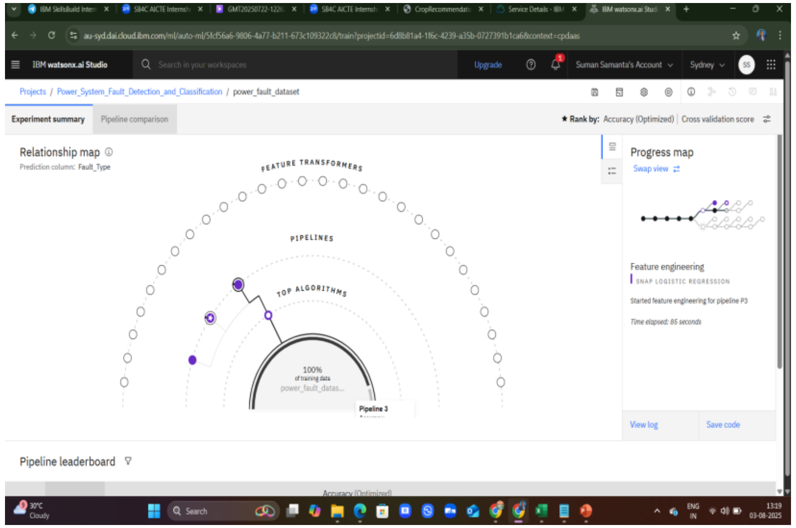
  Voltage, Current, Power Load, Weather, Component Health

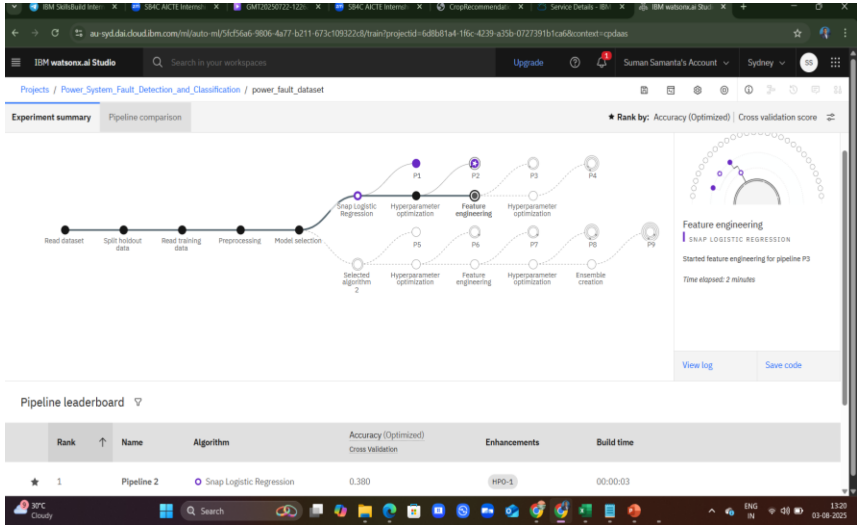
  Natural language queries related to electrical fault diagnosis
- **Steps:**
  1. Create Watsonx.ai Sandbox and Project
  2. Configure Agent: Select Granite model and enable necessary tools
  3. Add prompt flow to classify faults based on input conditions
  4. Save, deploy, and test the Agent using sample queries
- **Deployment:**

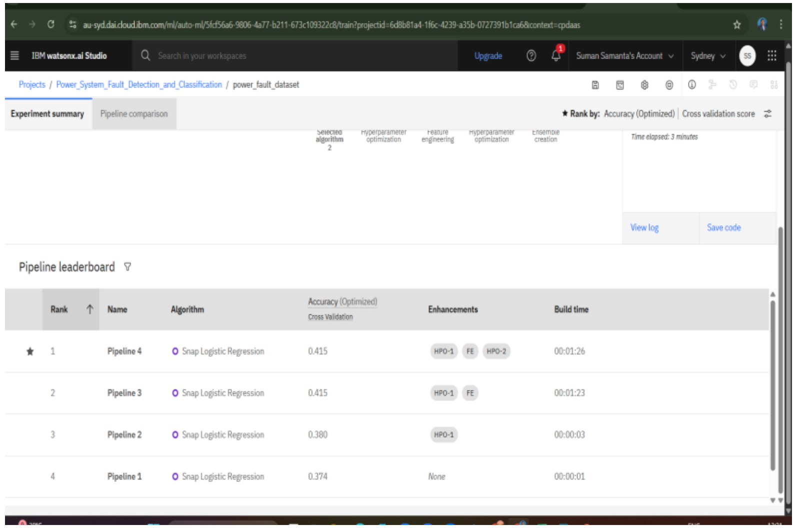
  Used Watsonx.ai Runtime service

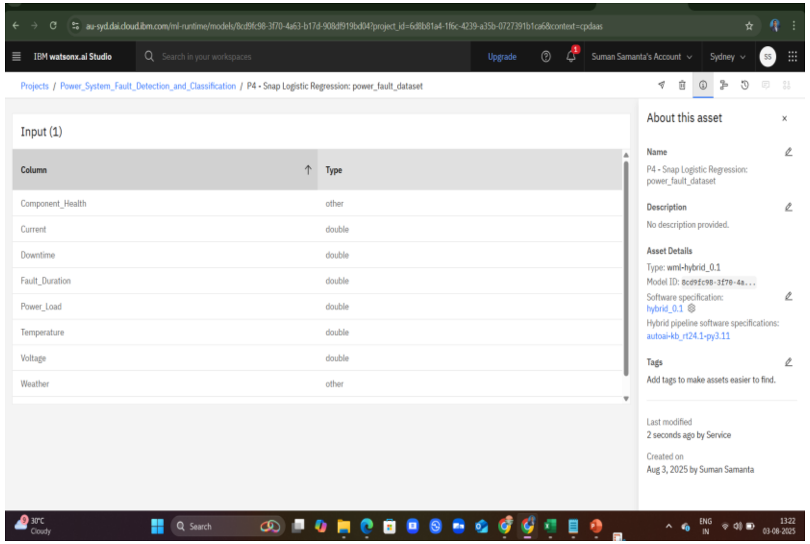
  Integrated API Key and Deployment Space for cloud hosting

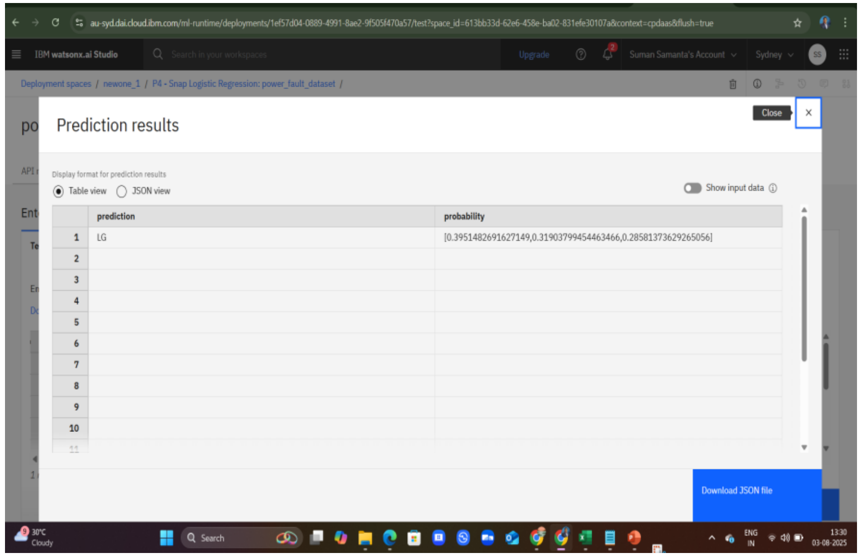
RESULT

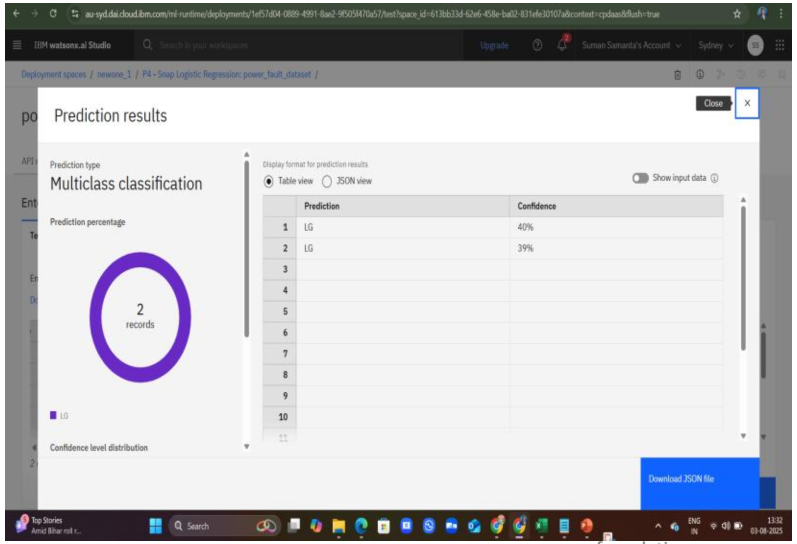












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CONCLUSION

- This system enables power grid operators to quickly detect and classify faults using AI-driven analysis. With the integration of IBM Cloud services, it provides scalable and fast inference, improving reliability and operational safety in the power system..

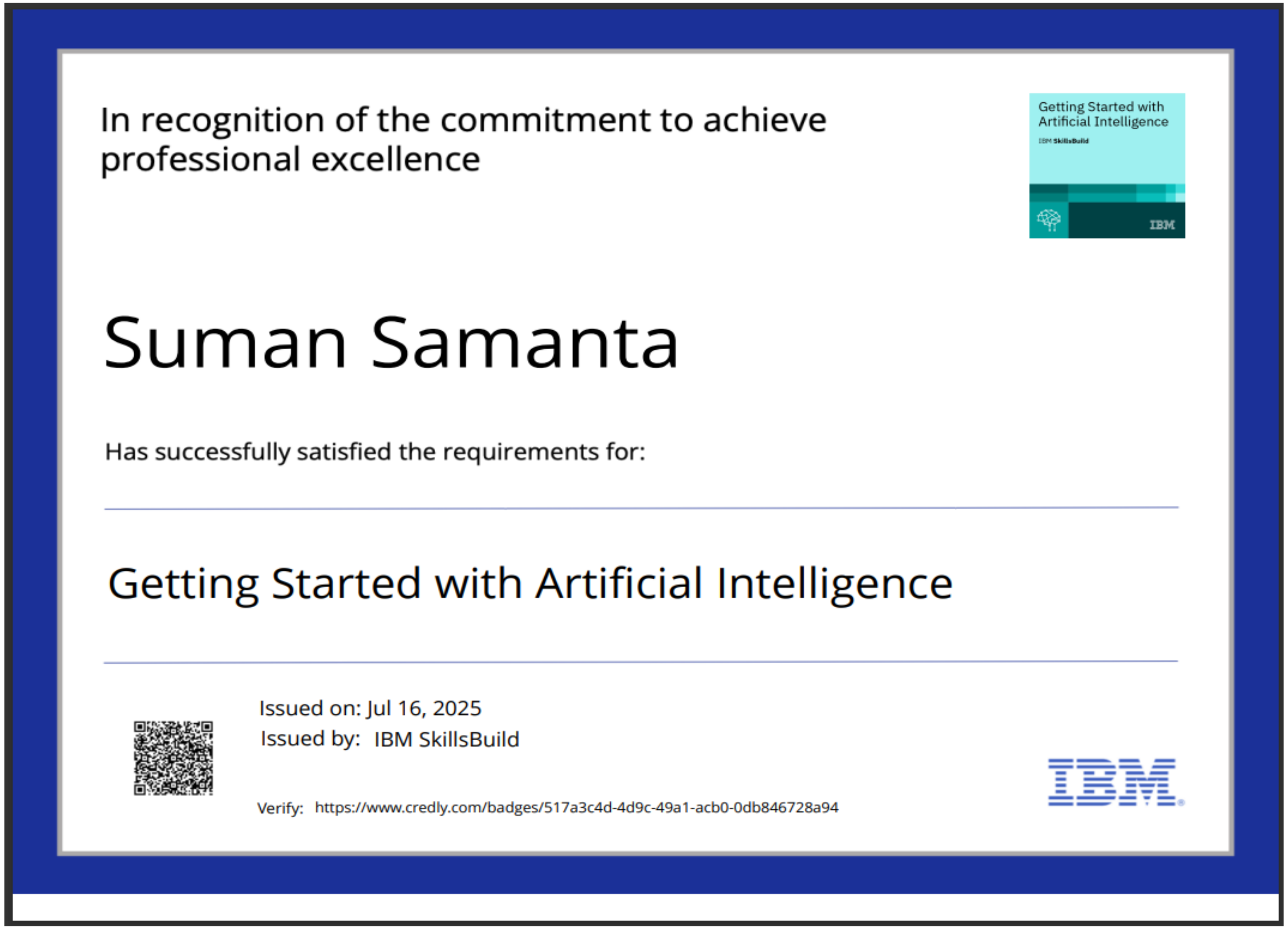
FUTURE SCOPE

- Extend model to handle real-time streaming data using IBM Streaming Analytics.
- Integrate with SCADA systems for direct fault alerts.
- Use deep learning models like LSTM for time-series fault prediction.

REFERENCES

- Kaggle Dataset: https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset or,
- Google Dataset: from ChatGPT
- IBM Cloud Docs
- IEEE Papers on Fault Detection Techniques
- scikit-learn documentation
- IBM Agentic AI Labs

IBM CERTIFICATIONS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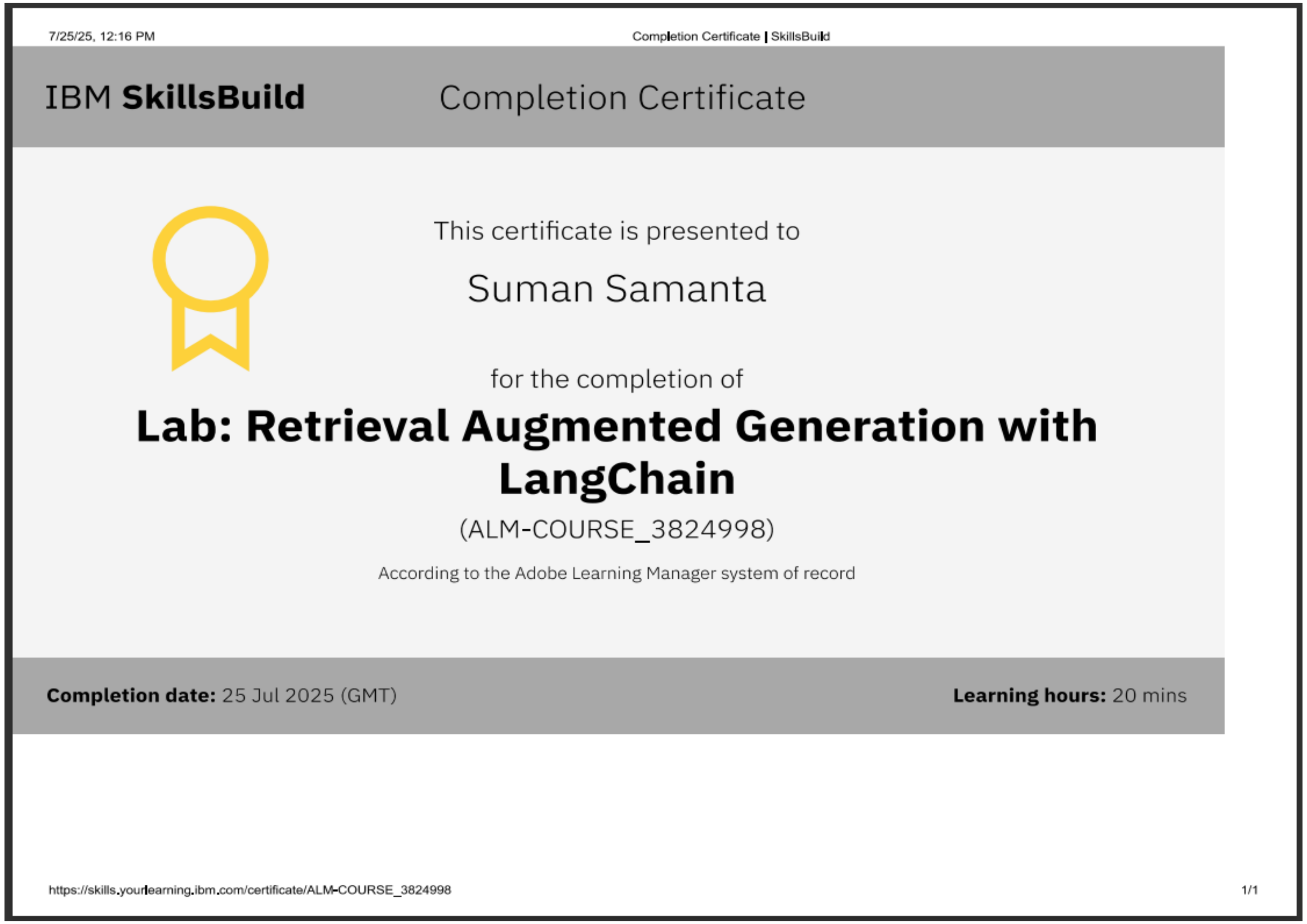

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