CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

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OUTLINE

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PROBLEM STATEMENT

Develop a machine learning-based system to detect and classify faults in a power distribution network using voltage and current phasor data. The model should accurately differentiate between normal conditions and faults such as line-to-ground, line-to-line, and three-phase faults. This enables fast, intelligent fault identification, ensuring improved grid reliability and operational efficiency.

PROPOSED SOLUTION

To build an intelligent fault detection system, we will leverage machine learning techniques trained on electrical measurement data. The solution pipeline involves:

- Data Preprocessing:
  - Clean and preprocess the collected data to handle missing values, outliers, and inconsistencies.
- Preprocessing & Feature Engineering:
  - Clean, normalize, and extract meaningful features to enhance model performance.
- Model Development:
  - Train and optimize fault classification models using algorithms like Random Forest, Support Vector Machine(SVM), or Neural Networks.
- Validation & Performance Benchmarking:
  - Evaluate model effectiveness using precision metrics like accuracy, recall, and F1-score to ensure reliable fault detection.

SYSTEM APPROACH

The "System Approach" section describes the overall methodology used to design, develop, and deploy the fault detection system using machine learning.

- System requirements :

➢ Laptop with minimum 8GB RAM & i5 Processor

➢ Reliable internet connection for cloud integration

- Library required to bulid the model :

➢ IBM Cloud (Essential platform)

➢ IBM Watsonx.ai Studio for model development & deployment

➢ IBM Cloud Object Storage for dataset access & management

➢ Kaggle dataset : fault.csv

ALGORITHM & DEPLOYMENT

- Model Selection

Random Forest used for fault classification; SVM considered for performance benchmarking.

- Data Input

Voltage, current, and phasor values extracted from dataset and pre-processed using IBM Cloud Storage.

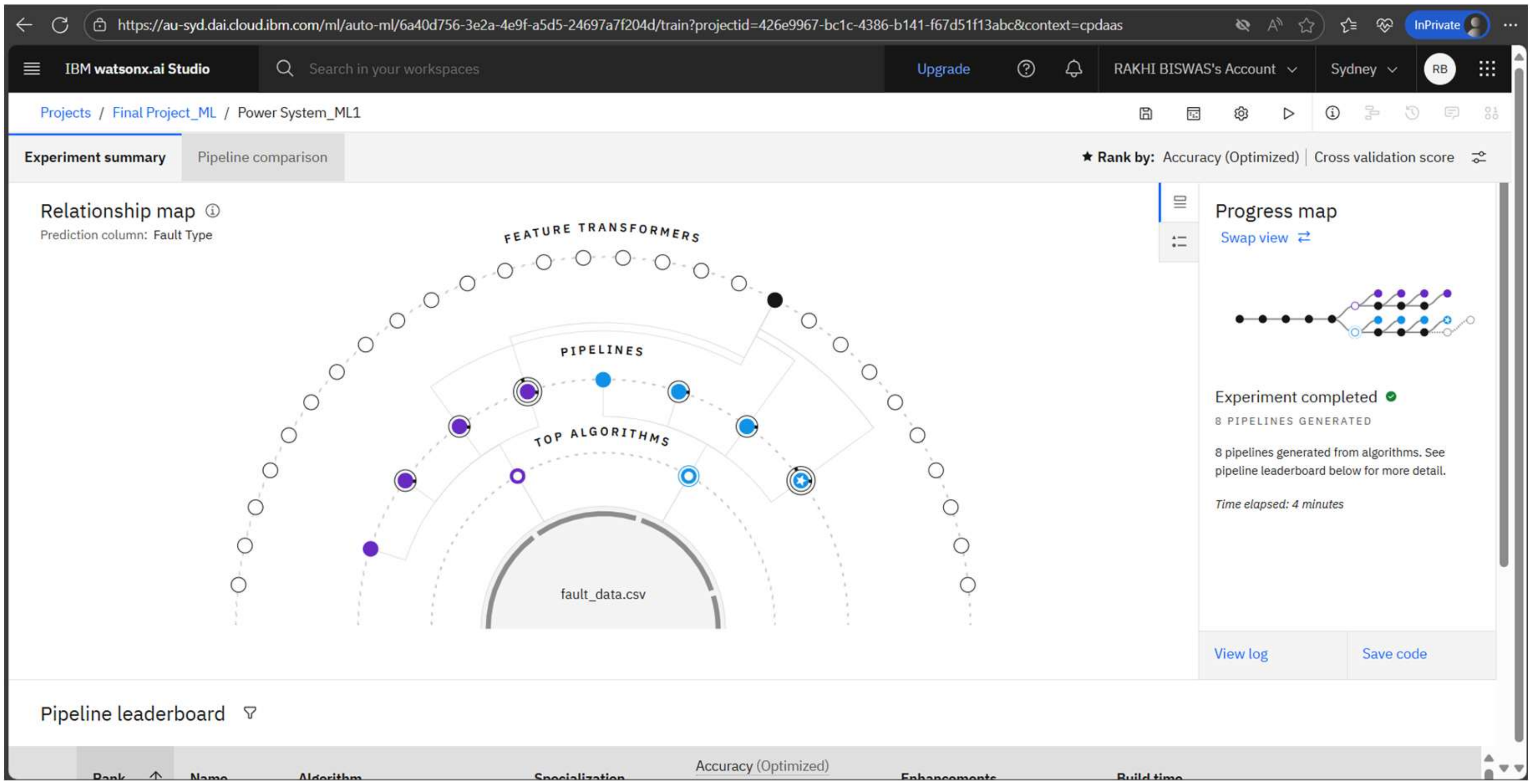
- Training

Supervised learning trains the model to identify labeled fault types efficiently.

- Deployment

Model deployed on IBM Watson Studio with real-time API for predictions and insights.

RESULT



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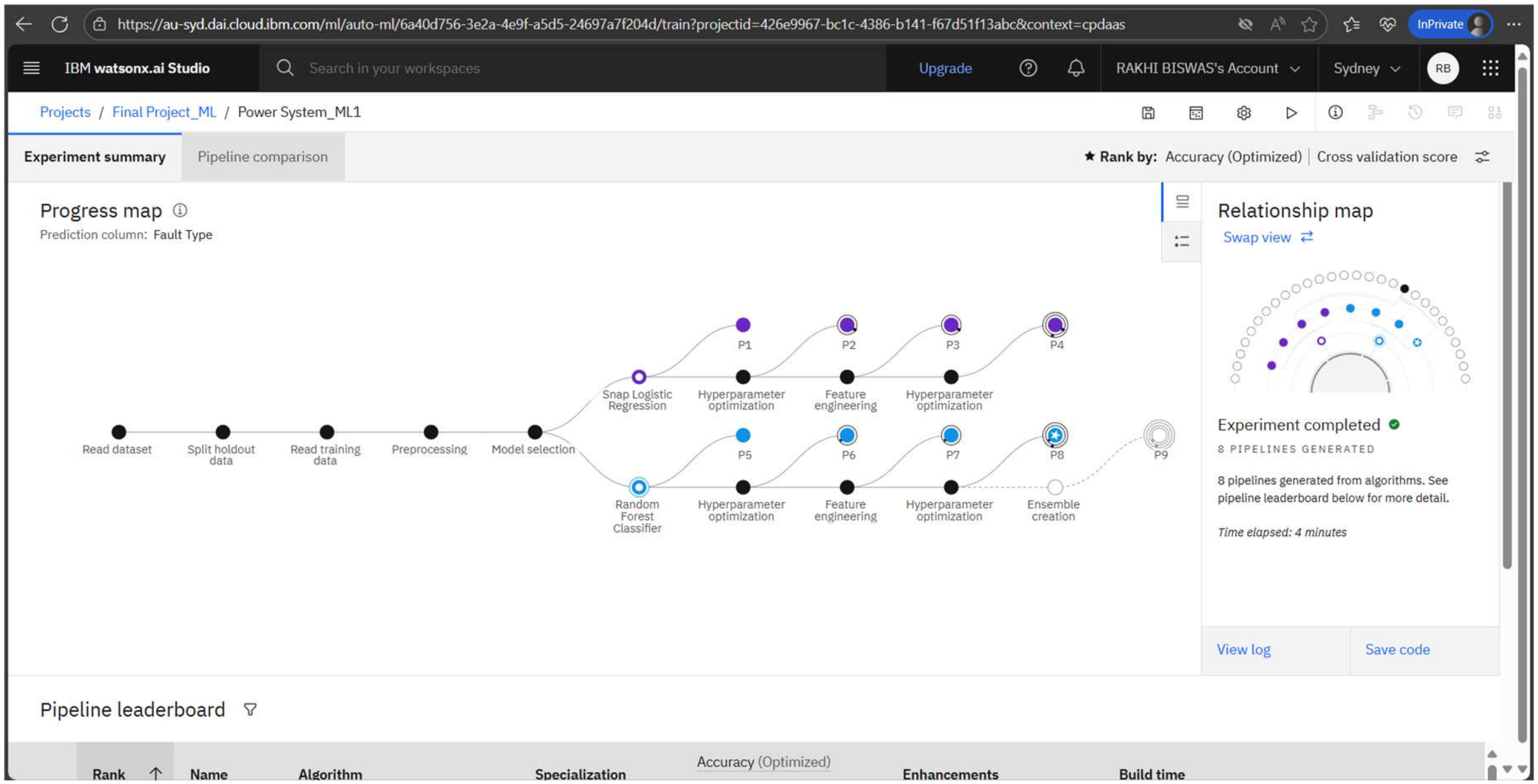
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
RAKHI BISWAS's Account
Sydney
Projects / Final Project_ML / Power System_ML1
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
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: 4 minutes
View log
Save code
Pipeline leaderboard
Accuracy (Optimized)

RESULT



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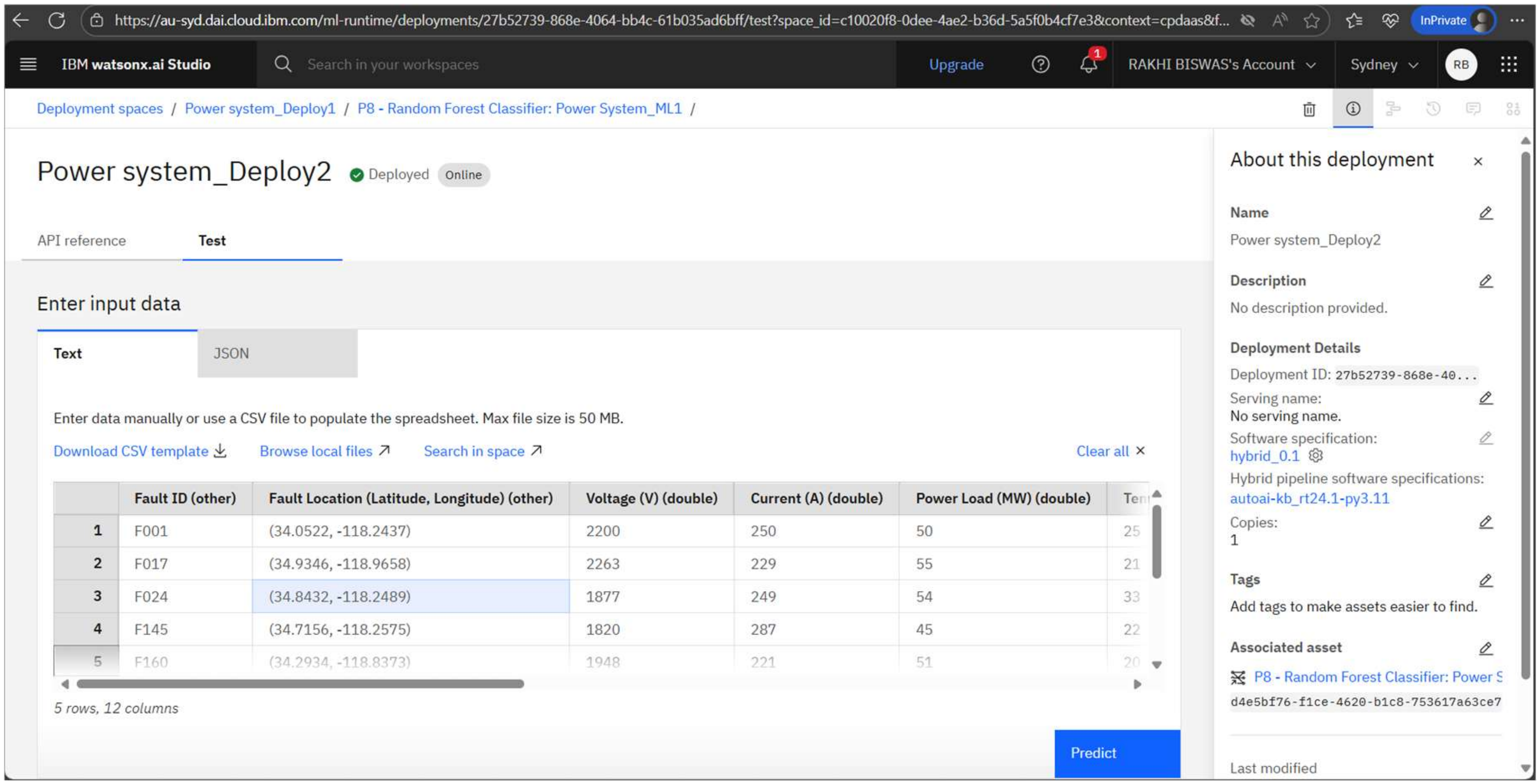
RESULT



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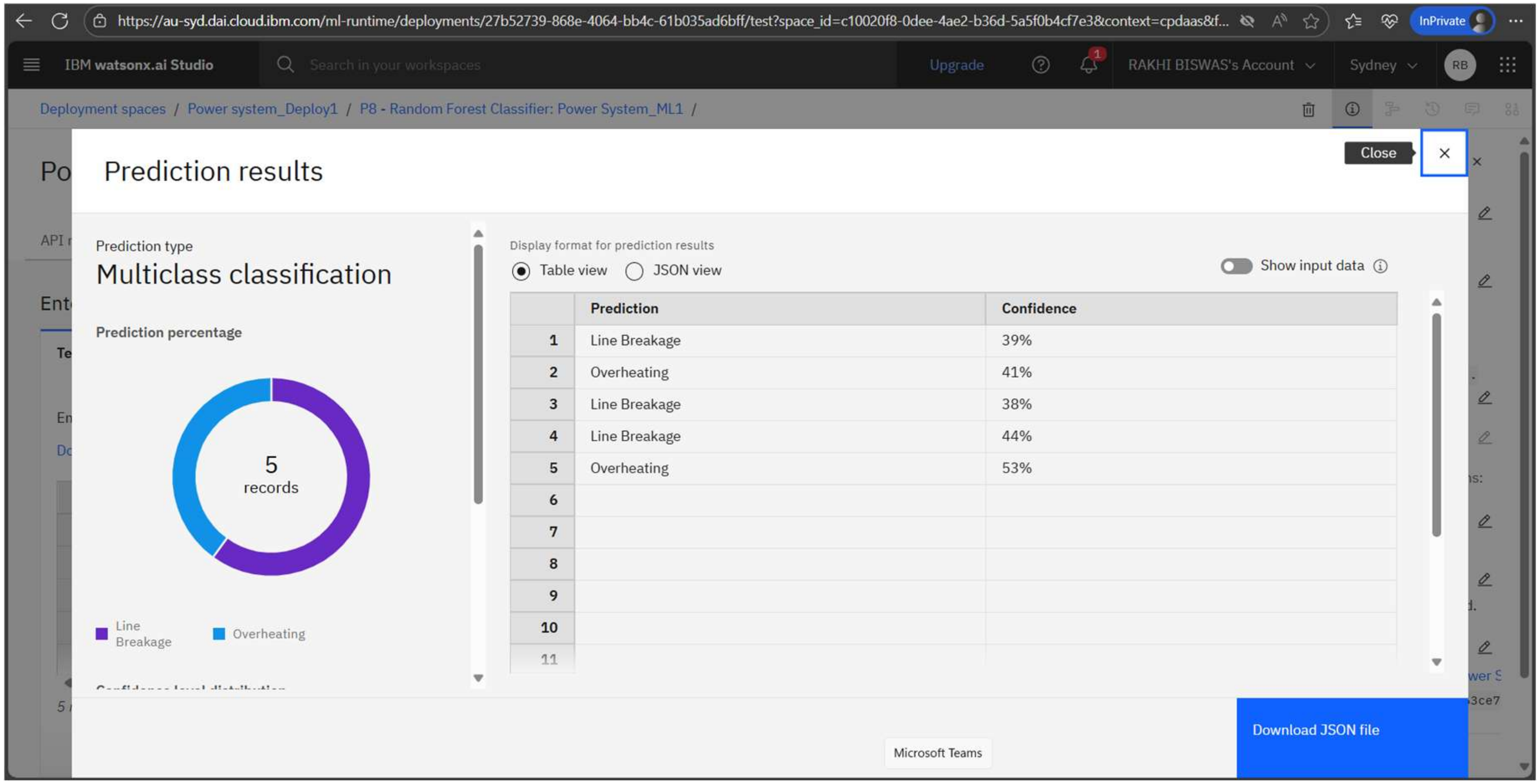
RESULT



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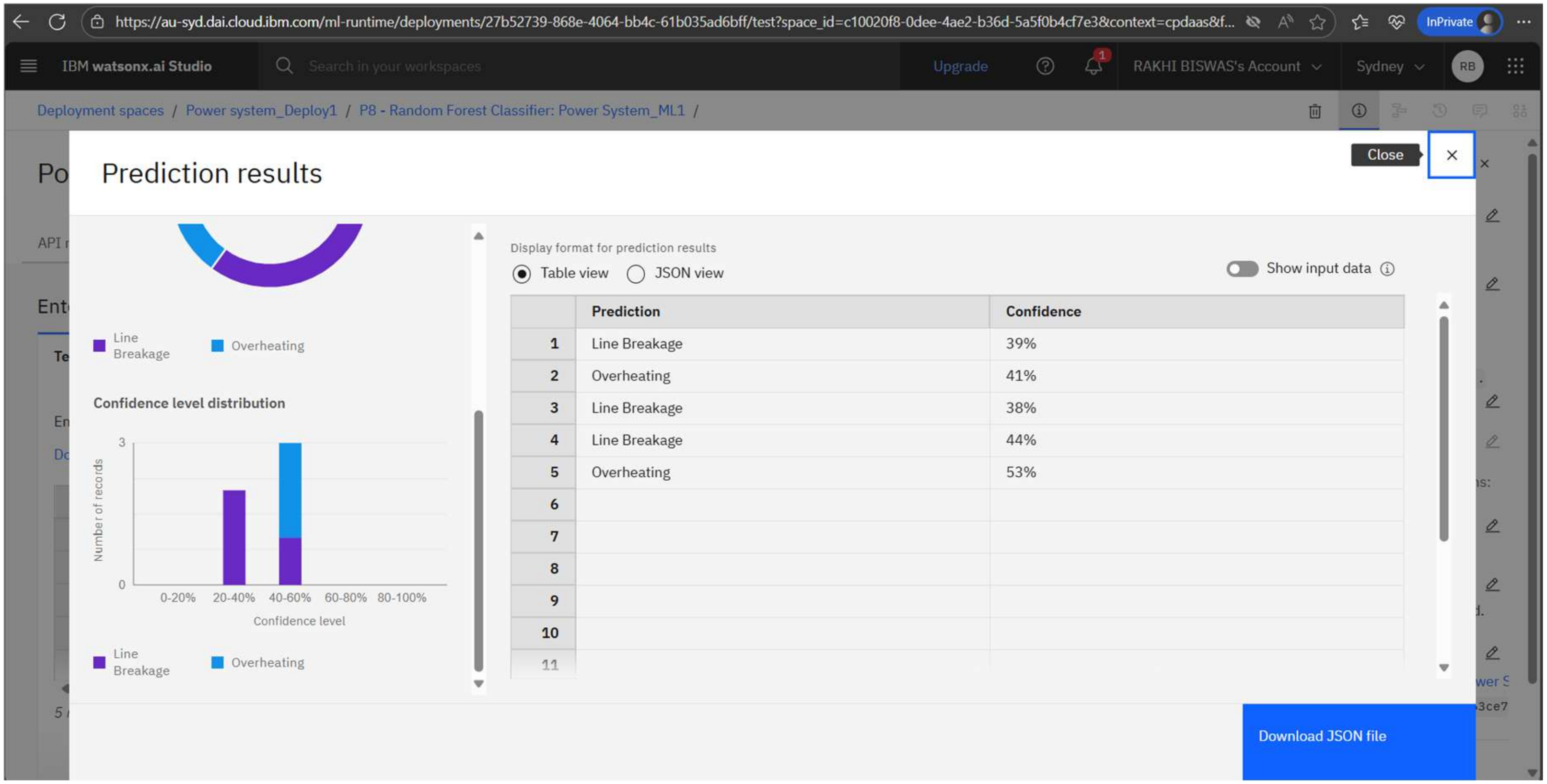
RESULT



	Prediction	Confidence
1	Line Breakage	39%
2	Overheating	41%
3	Line Breakage	38%
4	Line Breakage	44%
5	Overheating	53%
6		
7		
8		
9		
10		
11		

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CONCLUSION

- This project successfully demonstrates the potential of machine learning for intelligent fault detection and classification in power distribution systems. By leveraging IBM Cloud Watsonx.ai Studio, we built accurate and efficient models capable of identifying various fault types using voltage and current phasor data. The use of AutoAI accelerated model development and optimization, enabling real-time fault detection critical for ensuring grid reliability and safety. Despite challenges like data preprocessing and cloud deployment, the system showed strong performance. Future enhancements may include integration with real-time SCADA data, deep learning for time-series analysis, and interactive dashboards. Overall, this solution highlights the importance of combining ML with cloud platforms to create smart, scalable, and proactive power grid monitoring systems.

FUTURE SCOPE

- To elevate the effectiveness and scalability of the power system fault detection model, future enhancements may include integrating real-time SCADA, IoT, and environmental data to improve fault prediction accuracy. Advanced ML techniques like LSTM, CNN, and anomaly detection can boost performance, especially for complex or rare fault patterns. Optimizing algorithms through hyperparameter tuning, ensemble models, and feature selection will further refine detection. The system can also be expanded geographically to monitor faults across multiple cities or regions, adapting to diverse grid configurations. Leveraging edge computing and digital twins will enable faster, localized responses, while interactive dashboards using tools like Streamlit can improve operator decision-making. Together, these enhancements pave the way for a smart, resilient, and future-ready power grid.

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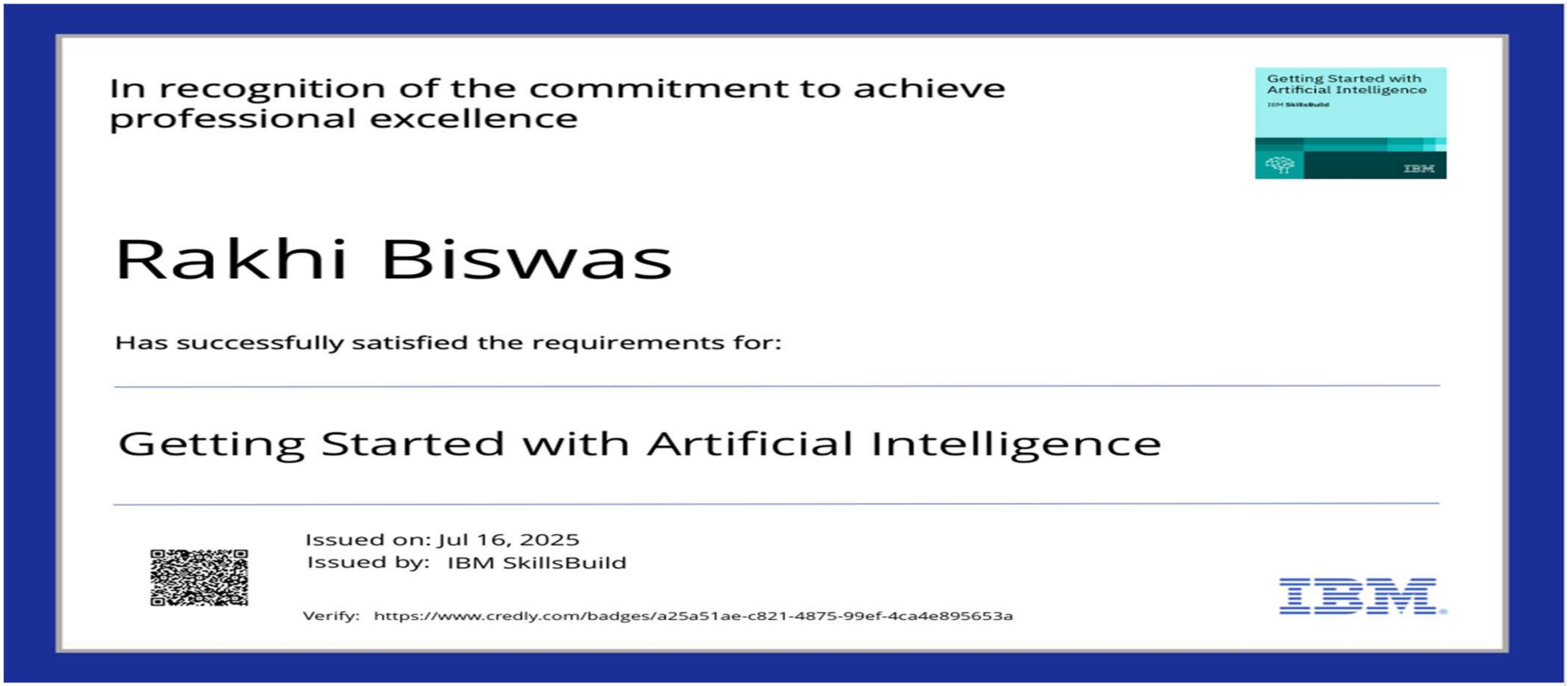
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