# CAPSTONE PROJECT

## POWERIQ: INTELLIGENT FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING


Presented By:

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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

Power distribution systems often face faults like line-to-ground, line-to-line, and three-phase short circuits. These faults can interrupt power flow and decrease the grid's overall reliability. To address this issue, the project aims to create a machine learning model that uses electrical data, including voltage, current, and phasors, to detect and classify different types of faults accurately. This will help improve response times for faults, reduce outages, and provide a more stable and efficient power supply.

# PROPOSED SOLUTION

- This project proposes the development of a machine learning-based system to detect and classify faults in power distribution networks. By analyzing electrical parameters such as voltage, current, and phasors, the model will accurately distinguish between normal conditions and fault types. This automated approach will enable faster response, minimize downtime, and enhance the overall reliability of the power grid.
- **Technical Components**
- **Dataset:** Kaggle dataset on power system faults
- **Preprocessing:** Cleaned and refined data for optimal model performance
- **Modeling:** Fault classification using ML models (e.g., SVM, Random Forest, Decision Tree)
- **Evaluation:** Measured using Accuracy, Precision, Recall, and F1-score

# SYSTEM APPROACH

- The system approach for **PowerIQ: Intelligent Fault Detection and Classification Using Machine Learning** leverages IBM Cloud tools to design, build, and deploy a scalable ML model for accurate fault identification in power systems. This method ensures high reliability, automation, and smooth integration with real-time grid monitoring systems.
- **System Requirements**

**IBM Cloud (Lite Tier):** Cloud platform for complete model development and deployment

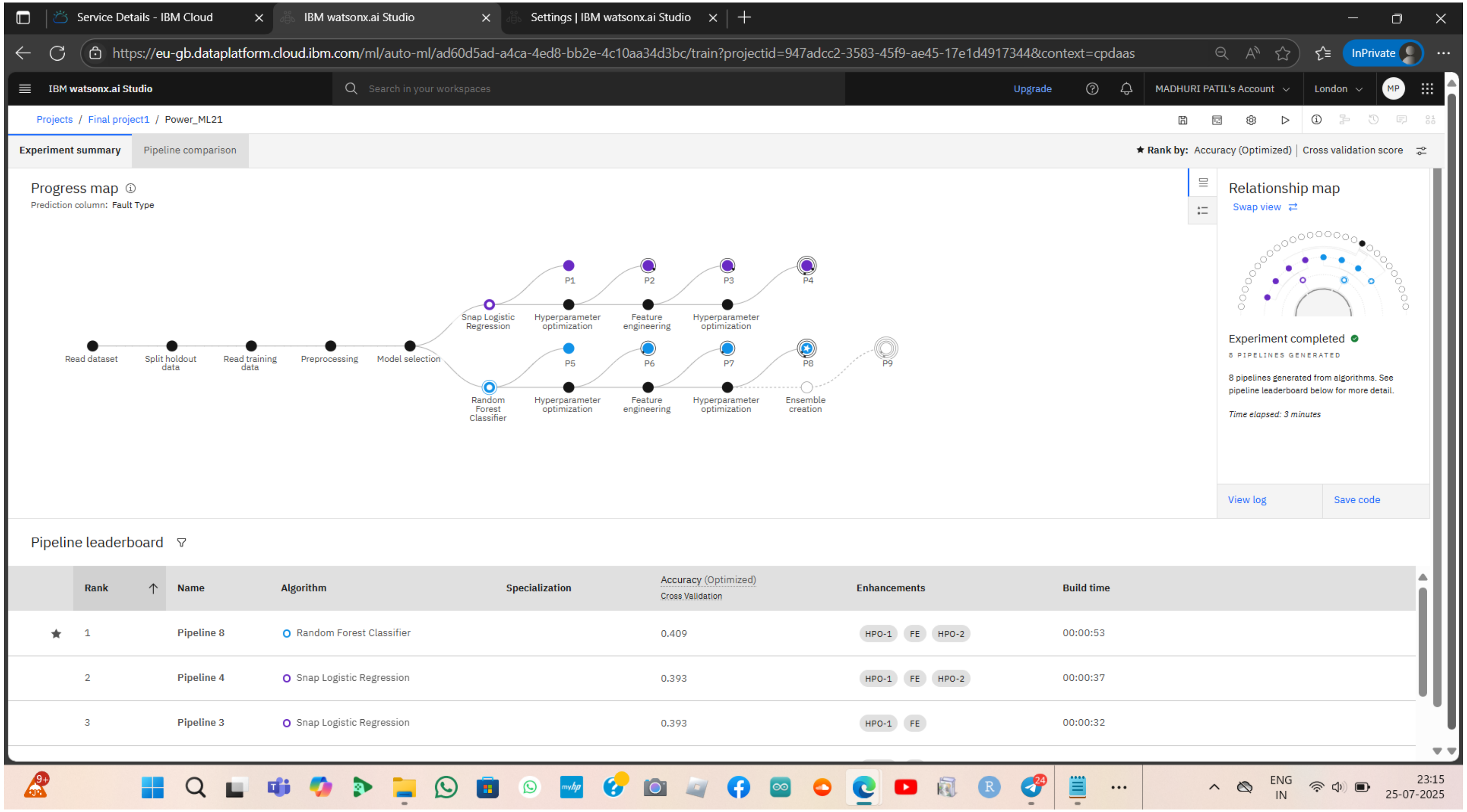
**IBM Watson Studio:** For building, training, and evaluating ML models using AutoAI and notebooks

**IBM Cloud Object Storage:** Securely stores the dataset for seamless access during preprocessing and training

# ALGORITHM & DEPLOYMENT

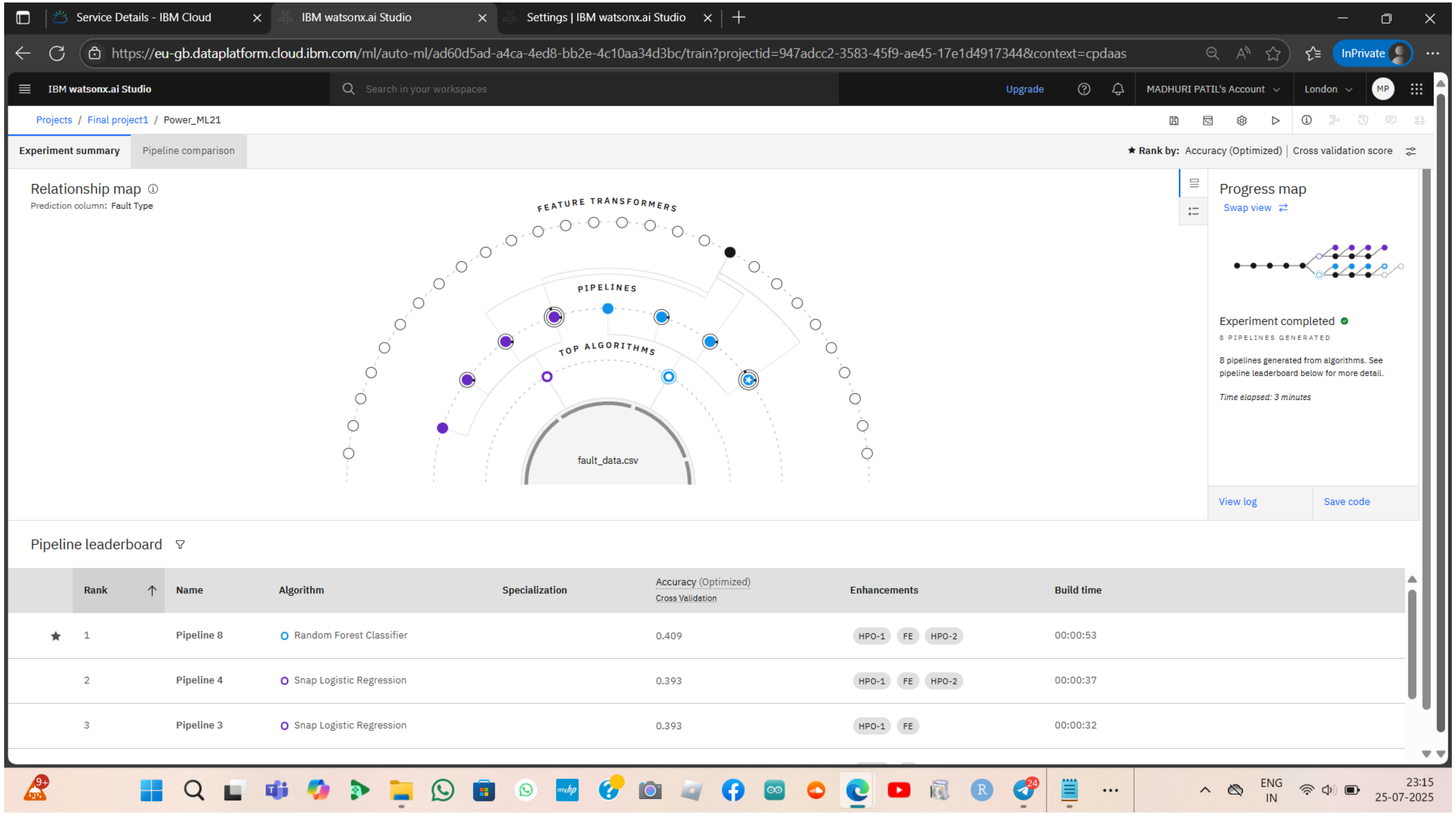
- **Algorithm Selection:**
  - Random Forest and SVM, selected for their accuracy and robustness.
- **Data Input:**
  - Voltage, current, and phasor readings from the dataset.
- **Training Process:**
  - Supervised learning with labelled fault types.
- **Prediction Process:**
  - Deployed on IBM Watson Studio with a secure API for real-time fault detection and integration.

# RESULT



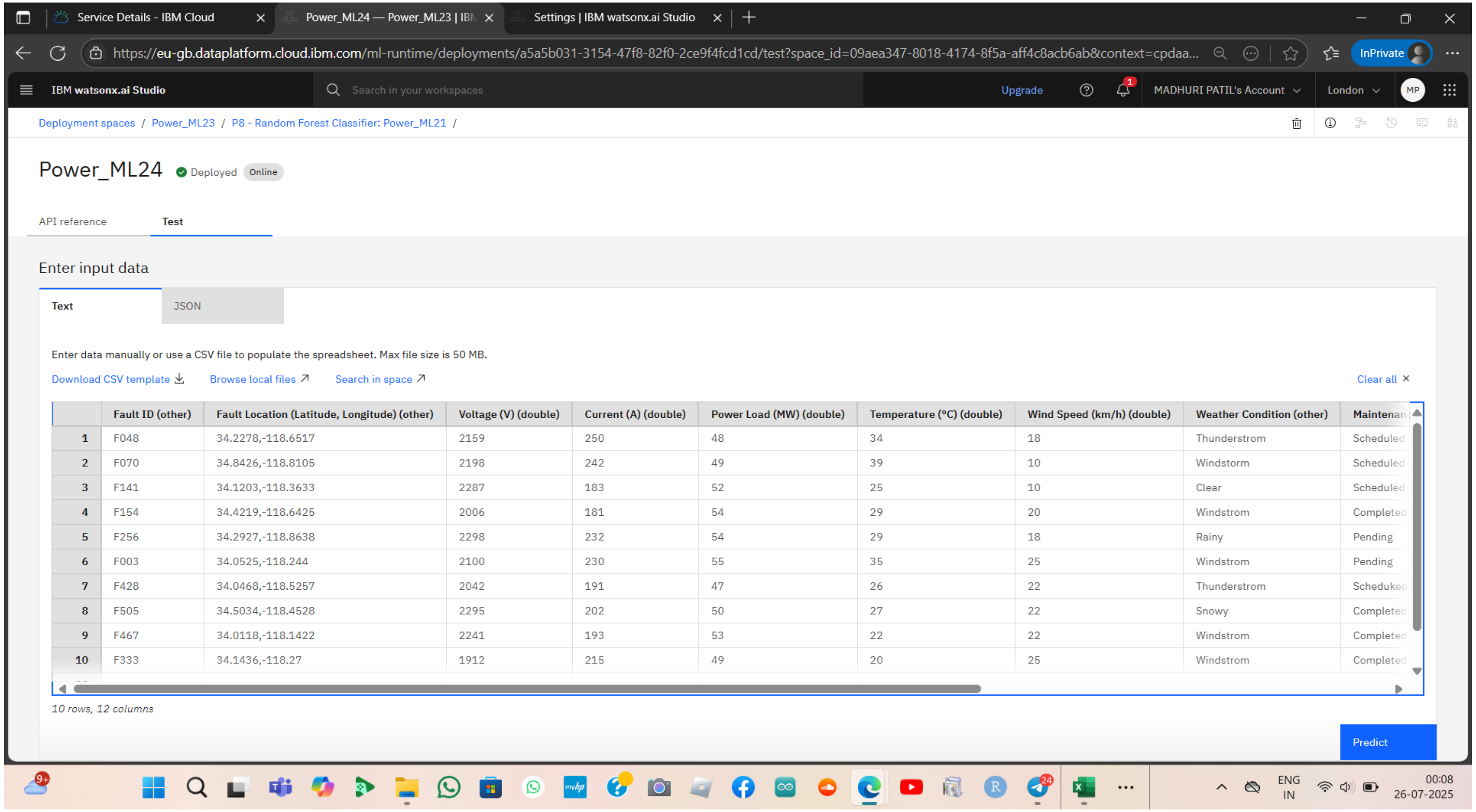

The pipeline illustrates how IBM AutoAI generated and fine-tuned multiple models automatically for better accuracy.

# RESULT




This visual map explains the link between input data, feature transformations, and machine learning models used in the process.

# RESULT




| | Fault ID (other) | Fault Location (Latitude, Longitude) (other) | Voltage (V) (double) | Current (A) (double) | Power Load (MW) (double) | Temperature (°C) (double) | Wind Speed (km/h) (double) | Weather Condition (other) | Maintenan |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F048 | 34.2278,-118.6517 | 2159 | 250 | 48 | 34 | 18 | Thunderstrom | Scheduled |
| 2 | F070 | 34.8426,-118.8105 | 2198 | 242 | 49 | 39 | 10 | Windstorm | Scheduled |
| 3 | F141 | 34.1203,-118.3633 | 2287 | 183 | 52 | 25 | 10 | Clear | Scheduled |
| 4 | F154 | 34.4219,-118.6425 | 2006 | 181 | 54 | 29 | 20 | Windstrom | Completed |
| 5 | F256 | 34.2927,-118.8638 | 2298 | 232 | 54 | 29 | 18 | Rainy | Pending |
| 6 | F003 | 34.0525,-118.244 | 2100 | 230 | 55 | 35 | 25 | Windstrom | Pending |
| 7 | F428 | 34.0468,-118.5257 | 2042 | 191 | 47 | 26 | 22 | Thunderstrom | Scheduled |
| 8 | F505 | 34.5034,-118.4528 | 2295 | 202 | 50 | 27 | 22 | Snowy | Completed |
| 9 | F467 | 34.0118,-118.1422 | 2241 | 193 | 53 | 22 | 22 | Windstrom | Completed |
| 10 | F333 | 34.1436,-118.27 | 1912 | 215 | 49 | 20 | 25 | Windstrom | Completed |

Here, sample fault data is submitted to the deployed model to check its prediction capability in real-time.

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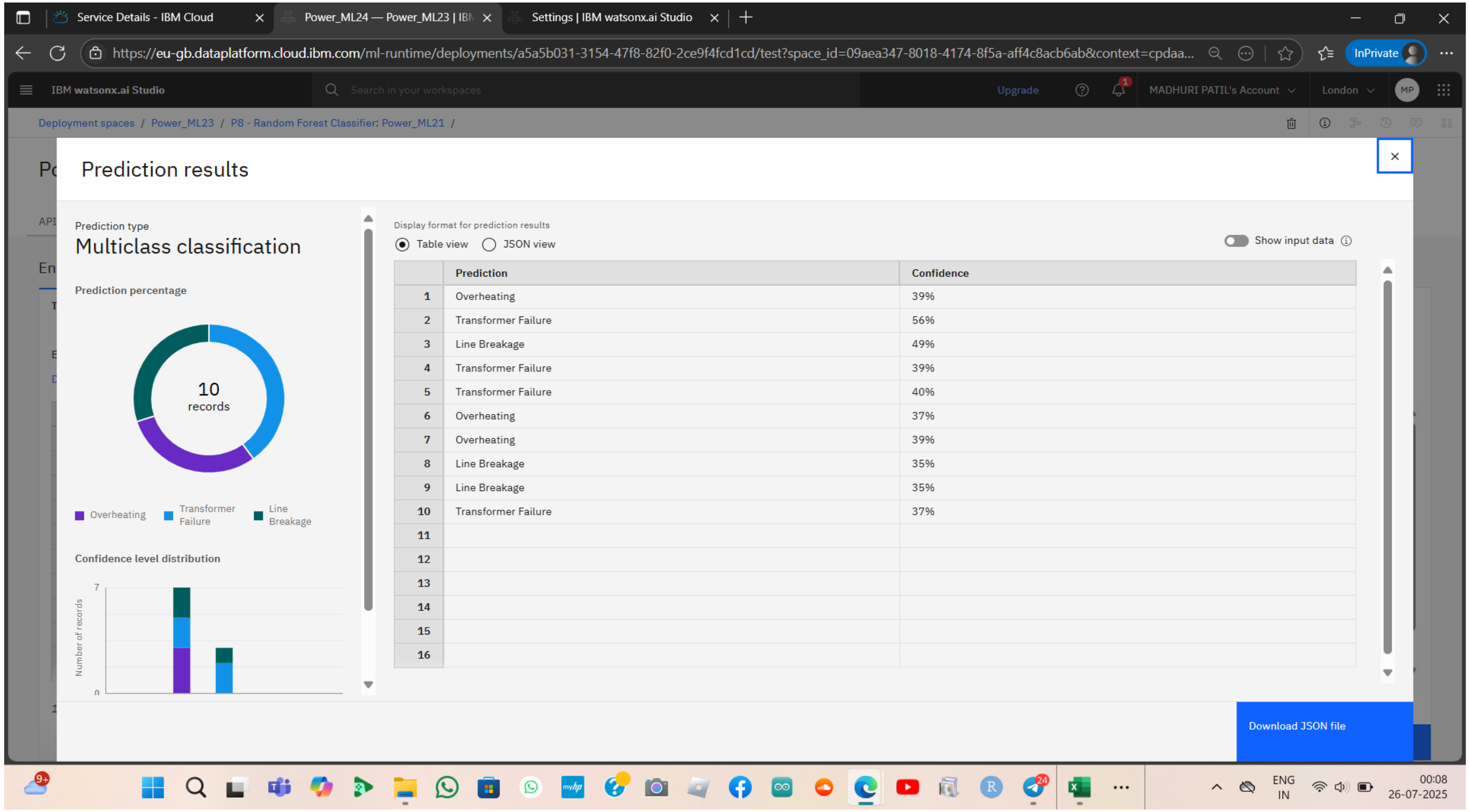
# RESULT




The results display predicted fault categories along with their associated confidence levels from the trained model.

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# CONCLUSION

- The project **PowerIQ** successfully demonstrates how machine learning can be effectively applied to detect and classify power system faults. By analyzing voltage, current, and phasor data, the model accurately identifies fault types such as line-to-ground, line-to-line, and three-phase faults. Using IBM Cloud services, the solution was built, trained, and deployed efficiently. The system enhances grid reliability by enabling quicker fault detection, reducing downtime, and supporting preventive maintenance strategies.

# FUTURE SCOPE

- **Real-Time Integration:** Implement real-time data streaming and integration with smart grid monitoring systems
- **Advanced Modeling:** Explore deep learning models such as CNNs or LSTMs for improved fault classification accuracy
- **Multi-Location Fault Detection:** Extend the system to detect and locate faults across multiple points in a distribution network
- **User Dashboard:** Build a visualization dashboard for utility operators to monitor faults in real time
- **Edge Deployment:** Adapt the model for deployment on edge devices in substations for faster on-site fault detection

# REFERENCES


- Kaggle – Power System Faults Dataset
- IBM Cloud Documentation – https://cloud.ibm.com/docs
- IBM Watson Studio – https://www.ibm.com/cloud/watson-studio
- "Machine Learning Applications in Power Systems," IEEE Access, 2023

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**Learning hours:** 20 mins

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