
CAPSTONE PROJECT

41.POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result
- Conclusion
- Future Scope

PROBLEM STATEMENT

Example: we design a machine learning model for identifying the faults in the power distribution system . Using the data provided ,the model should be able to differentiate different types of fault that occur .The main objective for this project is accurate fault type identification,which helps in maintaining the power grid stability and reliability.

PROPOSED SOLUTION

To detect and classify faults in a power distribution system, we propose a supervised machine learning-based solution that utilizes voltage and current phasor data collected from sensors such as Phasor Measurement Units (PMUs) or Intelligent Electronic Devices (IEDs). The solution includes the following steps:

- **1. Data Collection and Preprocessing** Collect time-series data of voltage and current phasors under both normal and various fault conditions (line-to-ground, line-to-line, and three-phase faults). Apply preprocessing techniques such as noise filtering, normalization, and feature extraction (e.g., magnitude, angle, rate of change).
- **2. Feature Engineering** Derive meaningful features such as sequence components, total harmonic distortion, and phase imbalances. Convert raw time-series into feature vectors or use sequence models to preserve temporal patterns.
- **3. Model Selection and Training** Use machine learning algorithms like Random Forest, Support Vector Machine (SVM), or deep learning models like LSTM (Long Short-Term Memory) for temporal pattern recognition. Train the model using labeled data, where each sample is tagged as normal or a specific fault type.
- **4. Fault Detection and Classification** Deploy the trained model to monitor real-time data and classify the system state. Upon detection of a fault, trigger alerts and identify the type of fault for appropriate corrective actions.
- **5. Evaluation and Deployment** Evaluate the model using accuracy, precision, recall, and confusion matrix to ensure high reliability. Integrate the system into the grid's monitoring infrastructure for real-time use and automate protection responses.

SYSTEM APPROACH

To complete the mentioned project we need the following different things with them creating the project becomes easier we also need dataset to enter for the following problem statement.

- System requirements

- ibm cloud

- Library required to build the model

- watson.ai

- (associate resource)watson.ai.runtime

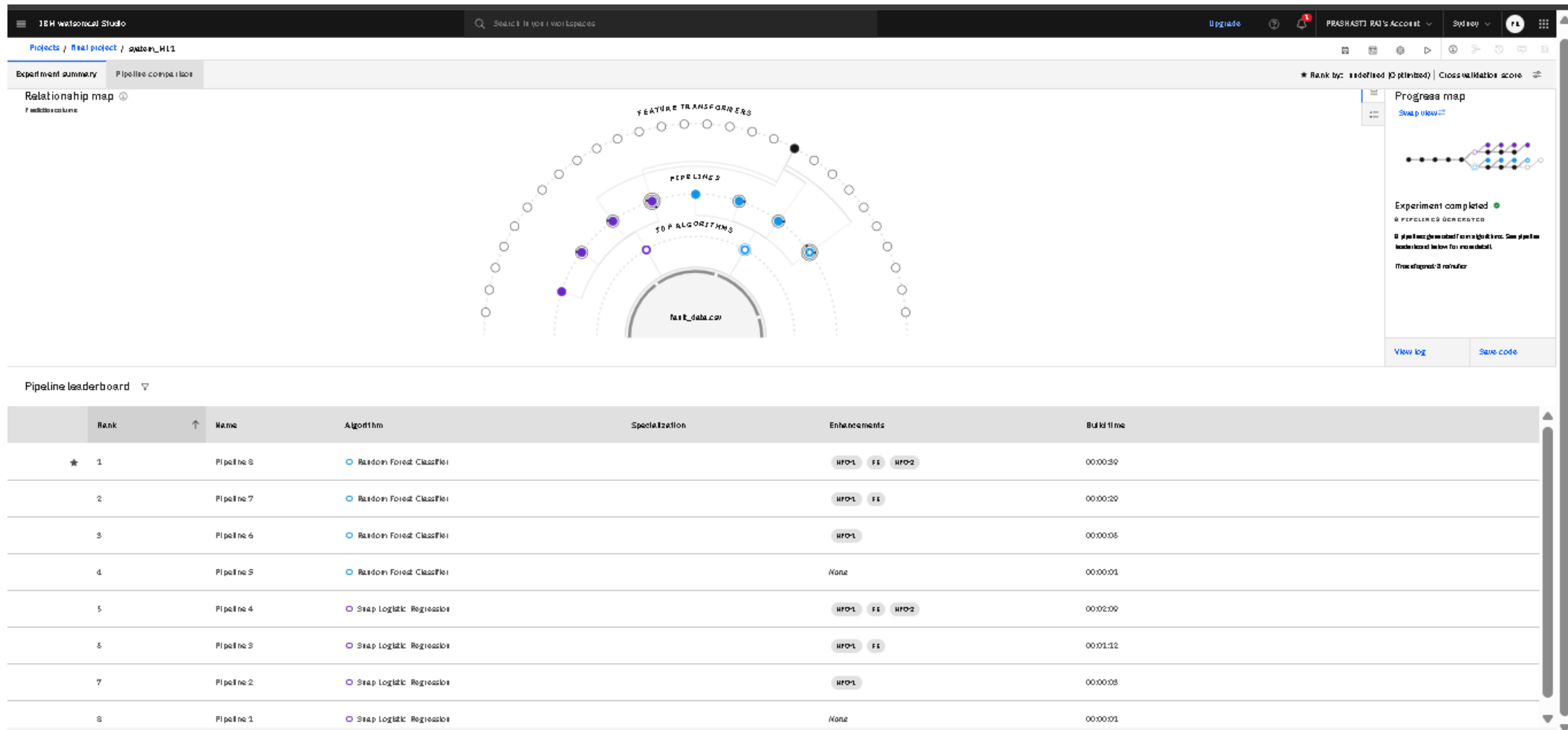
- Dataset

- Fault_data.csv

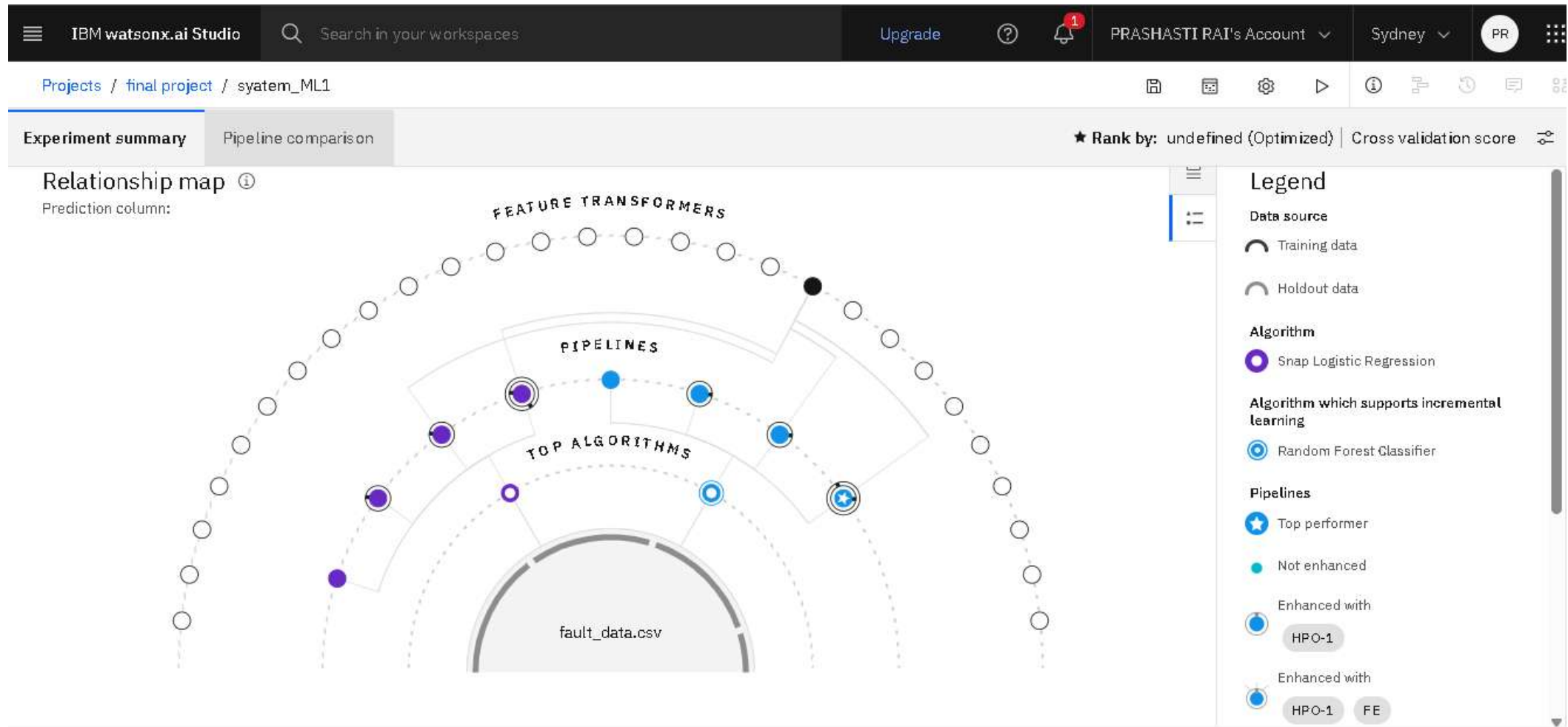
ALGORITHM & DEPLOYMENT

- **1. Data Collection:** Acquire real-time voltage and current phasor data under normal and fault conditions using PMUs or IEDs.
- **2. Preprocessing & Feature Extraction:** Clean and normalize the data, extract key features like magnitude, phase angle, and sequence components.
- **3. Model Selection & Training:** Choose and train a suitable machine learning model (e.g., Random Forest, SVM, LSTM) using labeled data, and validate its performance.
- **4. Fault Detection & Classification:** Use the trained model to classify input data into normal operation or specific fault types (line-to-ground, line-to-line, or three-phase).
- **5. System Integration:** Deploy the model within SCADA or substation automation systems to monitor and respond in real-time.
- **6. Data Streaming & Inference:** Enable continuous data flow via communication protocols (like IEC 61850) to the deployed model.
- **7. Real-Time Alerts & Protection:** Upon fault detection, automatically trigger alarms, isolate faults, or activate protective measures.
- **8. Monitoring & Continuous Improvement:** Monitor the system's accuracy and retrain the model periodically with updated data to adapt to grid changes.

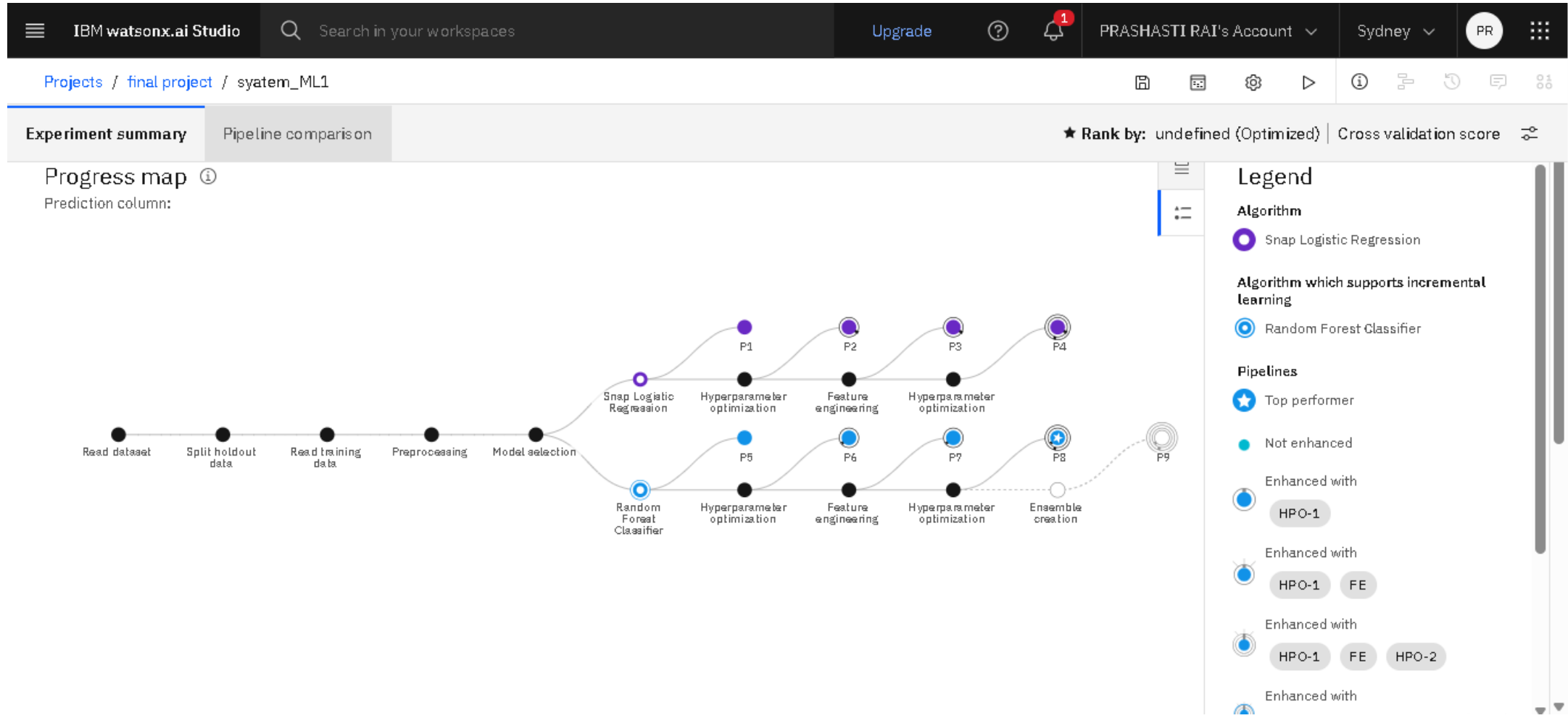
RESULT



RESULT



RESULT



RESULT

IBM watsonx.ai Studio

Search in your workspaces

Upgrade

PRASHASTI RAI's Account

Sydney

PR

Deployment spaces / SYSTEM_DPT1 / P8 - Random Forest Classifier: system_ML1 /

SYSTEM_DPT2 Deployed Online

API reference **Test**

Enter input data

Text

JSON

Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.

[Download CSV template](#) [Browse local files](#) [Search in space](#) [Clear all](#)

	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
1	F001	(34.0622,-118.2437)	2200	260	60	25	20	CLEAR
2	F003	(34.0625,-118.244)	2100	230	66	35	25	WINDSTORM
3	F016	(34.7106,-118.6379)	2102	246	66	38	18	RAINY
4								
5								
6								
7								
8								

3 rows, 12 columns

Predict

RESULT

Prediction results

Prediction type

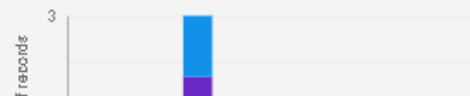
Multiclass classification

Prediction percentage



Line Breakage Overheating

Confidence level distribution



Display format for prediction results

☒ Table view ☐ JSON view

☐ Show input data ⓘ

	Prediction	Confidence
1	Line Breakage	39%
2	Overheating	37%
3	Line Breakage	38%
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

Download JSON file

CONCLUSION

- This machine learning model brings a smart and reliable way to protect our power systems. By learning from real electrical signals-like voltage and current – it can quickly tell the difference between normal operations and different types of faults. This means faster responses to issues, less damage to equipment, and fewer power outages for people and businesses. It's a step toward making our electricity grid more resilient and future-ready. As we continue to improve and integrate it with modern infrastructure, this technology can play a key role in keeping the lights on-safely and efficiently-for everyone.

FUTURE SCOPE

- The proposed machine learning model holds significant potential for future advancement in smart power systems. Integration with IoT-enabled smart grids and edge computing can enable real-time, decentralized fault detection with minimal latency. Adaptive learning and explainable AI will make the system more intelligent, transparent, and responsive to changing grid conditions. By incorporating data from multiple sources—such as environmental sensors or maintenance logs—the model can become even more accurate and predictive. Additionally, expanding to wide-area monitoring systems and integrating cybersecurity awareness will make the grid more secure and resilient. These innovations pave the way for a more automated, reliable, and intelligent power distribution network.

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Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins



THANK YOU