CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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OUTLINE

- **Problem Statement**
- **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 condition sand 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

1. Data Collection
   - Gather real-time voltage and current phasor data from sensors and IEDs.
   - Use historical fault logs and SCADA records to label data for training.
2. Data Preprocessing
   - Clean and normalize data to remove noise and handle missing values.
   - Extract key features like sequence components and phase angles.
3. Machine Learning Model
   - Develop a classifier to detect and distinguish fault types:
     - Line-to-Ground, Line-to-Line, Three-Phase, etc.
   - Train using labeled fault data and tune for best accuracy.
4. System Deployment
   - Integrate the model with real-time monitoring on IBM Cloud.
   - Display fault alerts and insights through dashboards.
   - Optionally deploy on edge devices for faster responses.
5. Evaluation and Optimization
   - Measure performance using Accuracy, Precision, Recall, and F1-score.
   - Continuously improve the model with new data and feedback.

SYSTEM APPROACH

- IBM Cloud
- Watsonx.ai studio service
- Snap random forest classifier

ALGORITHM & DEPLOYMENT

- Data Collection
  - Collect real-time voltage/current data from sensors via IoT devices.
  - Use SCADA logs and historical fault records with labels (LG, LL, LLG, LLL, Normal).
- Data Preprocessing
  - Clean and normalize data in **IBM Watson Studio**.
  - Extract features (e.g., sequence components, phase angles).
  - Select key indicators using PCA or correlation.
- Model Development
  - Build a classifier (e.g., Random Forest/XGBoost) in **Watson Machine Learning**.
  - Train on labeled fault data and tune hyperparameters.
- Evaluation
  - Use Accuracy, Precision, Recall, and F1-Score in Watson Studio.
  - Analyze confusion matrix for performance.
- Fault Detection
  - Run real-time inference on incoming phasor data.
  - Classify fault type and trigger alerts.

DATA INPUTS

Deployment spaces / Fault_1 / P4 - Snap Logistic Regression: Fault_Finder /

Fault_1

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 Type (other)	Fault Location (Latitude, Longitude) (other)	Voltage (V) (double)	Current (A) (double)	Power Load (MW) (double)	Temperature (°C) (double)	V
1	F001	Line Breakage	(34.0522, -118.2437)	2200	250	50	25	2
2	F002	Transformer Failur	(34.056, -118.245)	1800	180	45	28	1
3	F003	Overheating	(34.0525, -118.244)	2100	230	55	35	2
4	F004	Line Breakage	(34.055, -118.242)	2050	240	48	23	0
5								
6								

4 rows, 12 columns

Predict

RESULT

Prediction results

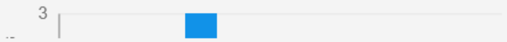
Prediction type

Multiclass classification

Prediction percentage

Faulty Normal Overheated

Confidence level distribution



Display format for prediction results

Table view JSON view

Show input data

	Prediction	Confidence
1	Faulty	39%
2	Normal	38%
3	Overheated	42%
4	Faulty	38%
5		
6		
7		
8		
9		
10		
11		
12		

Download JSON file

CONCLUSION

- This project successfully demonstrates the use of machine learning on IBM Cloud to detect and classify various faults in a power distribution system. By leveraging real-time electrical measurement data and historical fault records, the model can accurately identify fault types such as line-to-ground, line-to-line, and three-phase faults.
- The solution, developed using IBM Watson Studio and deployed via IBM Cloud services, enhances the speed and accuracy of fault detection, ensuring timely alerts and improved grid reliability. This approach not only reduces downtime but also supports proactive maintenance and operational efficiency in modern power systems.

FUTURE SCOPE

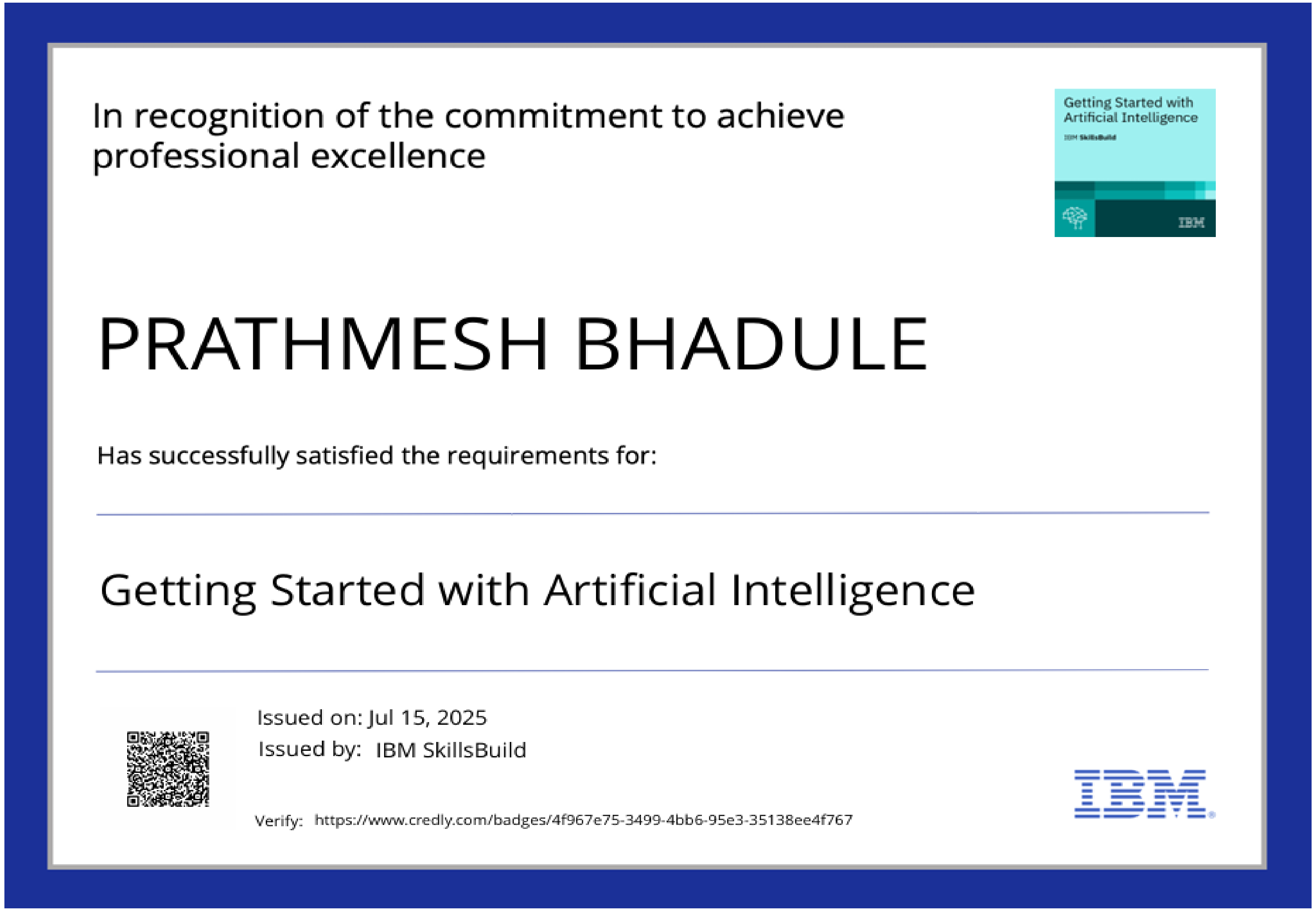
- **IoT Integration**
  Connect the model with IoT-enabled smart meters and PMUs for real-time grid monitoring and instant fault notifications.
- **Model Generalization**
  Extend the model to support fault detection in various power system configurations, including rural, urban, and microgrid networks.
- **Advanced AI Techniques**
  Incorporate deep learning models like LSTM or CNN to capture complex temporal patterns in fault signals for improved accuracy.
- **Automated Grid Response**
  Integrate the system with automated protection and switching mechanisms to isolate faults and restore supply faster.
- **Scalable Cloud Monitoring**
  Deploy across IBM Cloud to centrally monitor large power networks, enabling utility companies to manage faults at scale with minimal latency.

REFERENCES

- https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset

IBM CERTIFICATIONS

- certificate(Getting started with AI)



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