CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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OUTLINE

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- System Development Approach
- Algorithm & Deployment
- Result
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PROBLEM STATEMENT

Power distribution networks must ensure uninterrupted electricity supply, but unexpected faults like line-to-ground, line-to-line, and three-phase faults can disrupt stability. This project aims to develop a machine learning model that uses voltage and current phasors to detect and classify such faults in real time. Using a Kaggle dataset and IBM Cloud Lite services, the solution will help improve grid reliability and enable faster fault response.

PROPOSED SOLUTION

The proposed system addresses the challenge of detecting and classifying power system faults to ensure grid stability and quick response. This involves applying machine learning techniques to electrical measurement data (voltage and current phasors) for real-time fault identification. The solution includes the following components:

- **Data Collection:** Use a Kaggle dataset with labeled records of normal and various fault types.
- **Preprocessing:** Clean data, handle anomalies, normalize phasors, and extract relevant features.
- **Modeling:** Train supervised ML models (e.g., SVM, Random Forest, Neural Networks) for fault classification.
- **Deployment:** Deploy the model on IBM Cloud Lite for real-time fault detection.
- **Evaluation:** Assess performance using accuracy, precision, recall, and F1-score; fine-tune with cross-validation.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the Power System Fault Detection and Classification system. Here's a suggested structure for this section:

- System requirements:
  - IBM Cloud (Mandatory)
  - IBM Watsonx.ai studio and Watsonx.ai runtime for development and deployment
  - IBM Cloud object storage for dataset handling

ALGORITHM & DEPLOYMENT

- **Algorithm:** Random Forest Classifier chosen for its accuracy and ability to handle complex fault patterns.
- **Data Input:** Voltage, current, power load, temperature, fault ID & location, wind speed, weather, maintenance status, component health, fault duration, and downtime.
- **Training:** Supervised learning on labeled fault type data with cross-validation and tuning.
- **Deployment:** Deployed on IBM Watsonx.ai Studio with API endpoints for real-time fault prediction.

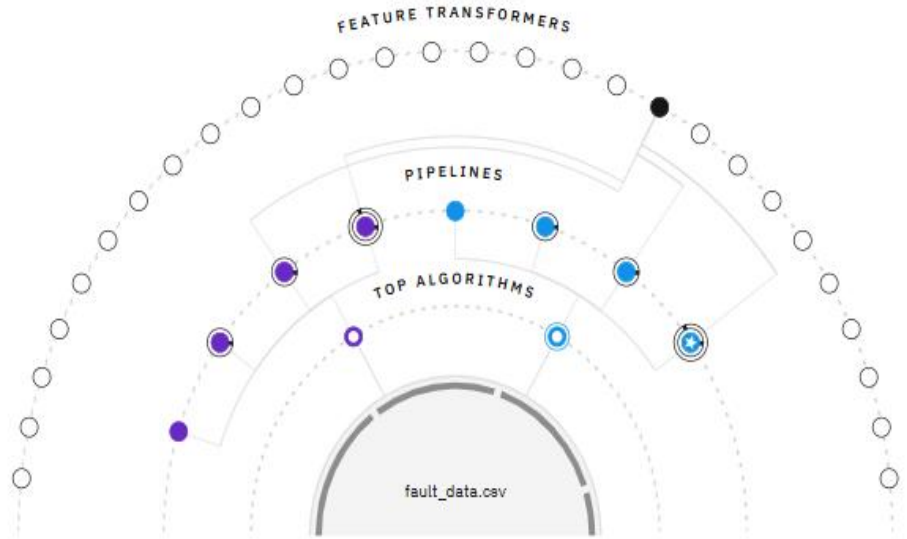
RESULT

Projects / Fault_Detection_MLProject / Final_Project

Experiment summary | Pipeline comparison | ★ Rank by: Accuracy (Optimized) | Cross validation score

Relationship map

Prediction column: Fault Type



Pipeline leaderboard

	Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 8	Random Forest Classifier		0.409	HPO-1 FE HPO-2	00:00:45

Best Performer Algorithm - Random Forest Classifier

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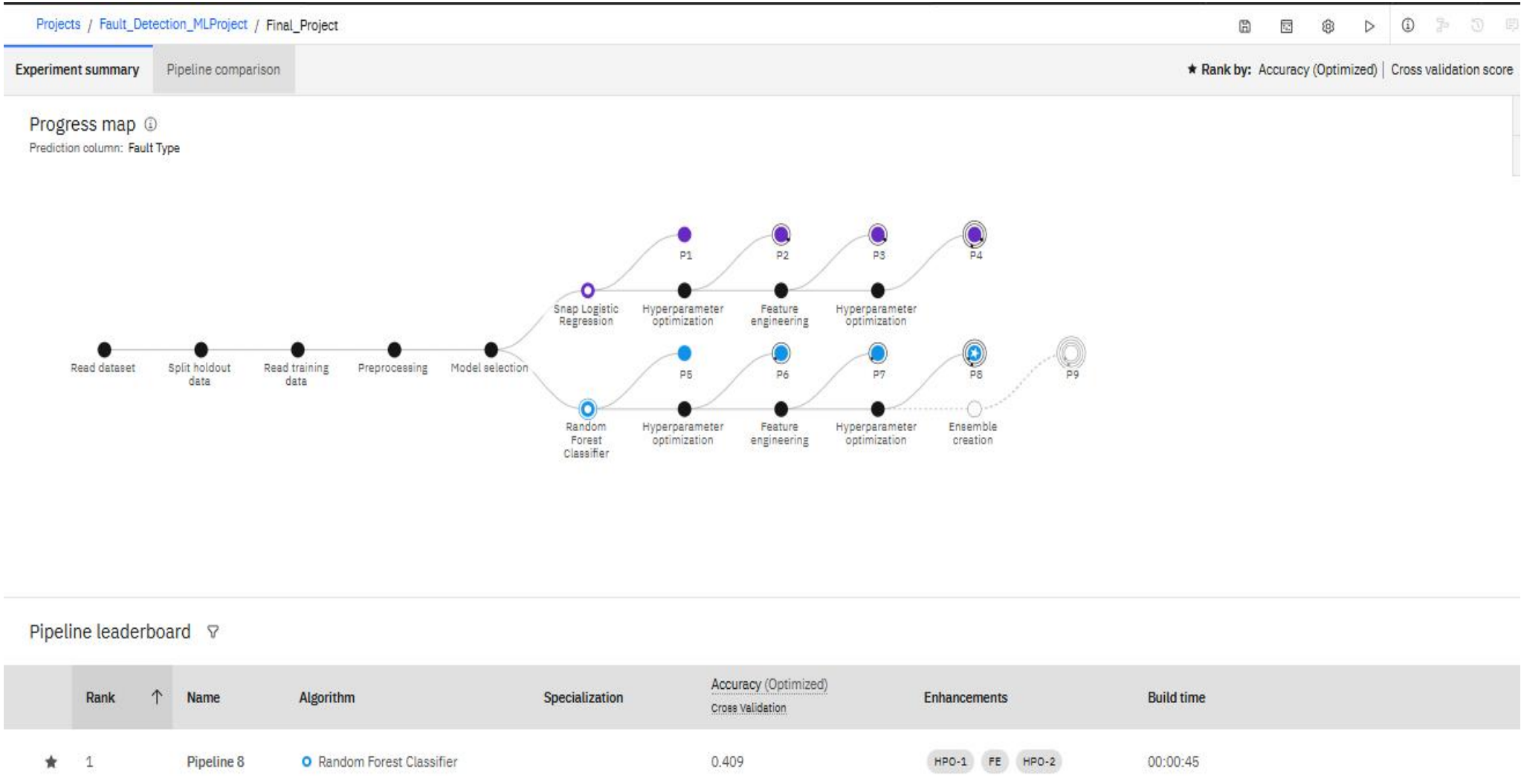
RESULT



Best Performer Algorithm - Random Forest Classifier

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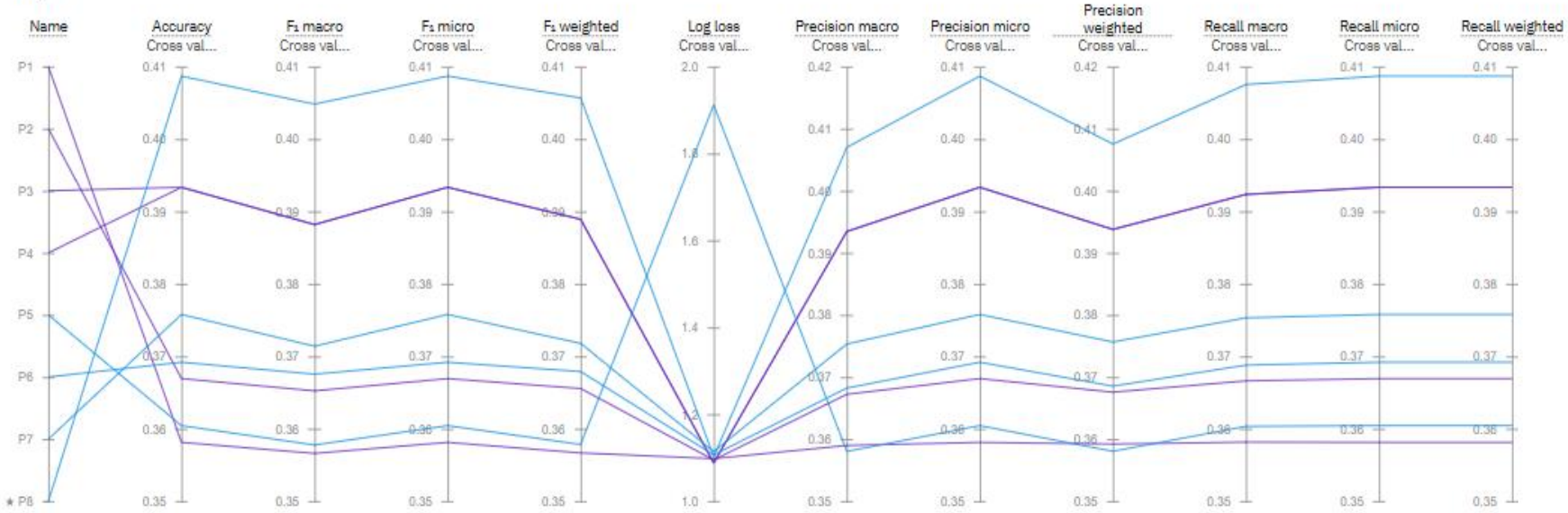
RESULT

Projects / Fault_Detection_MLProject / Final_Project

Experiment summary | **Pipeline comparison** | ★ **Rank by:** Accuracy (Optimized) | Cross validation score

Metric chart

Prediction column: Fault Type



Pipeline leaderboard

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RESULT

Fault_Deploy2 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 (other)
1	F051	(34.6747, -118.6695)	2091	245	51	24	27	Thunderstorm
2	F008	(34.2294, -118.2988)	2133	229	52	20	18	Snowy
3	F021	(34.1203, -118.2873)	1864	224	49	34	23	Thunderstrom
4	F085	(34.4523, -118.0953)	2289	232	45	26	16	Snowy
5	F065	(34.048, -118.972)	2294	218	51	26	21	Thunderstorm
6								
7								
8								

5 rows, 12 columns

RESULT

Prediction results

Prediction type

Multiclass classification

Prediction percentage

Display format for prediction results

(•) Table view ( ) JSON view

Show input data

	Prediction	Confidence
1	Transformer Failure	40%
2	Transformer Failure	47%
3	Line Breakage	40%
4	Overheating	38%
5	Transformer Failure	37%
6		
7		

Download JSON file

CONCLUSION

- This project demonstrates an efficient approach to detecting and classifying faults in power distribution systems using machine learning. By leveraging a Random Forest Classifier trained on electrical and environmental data, the system accurately identifies various fault types in real-time. Deployment on IBM Watsonx.ai Studio ensures scalability and accessibility, enabling faster response times and improving overall power grid reliability and stability.

FUTURE SCOPE

- Integration with Smart Grid Systems for automated fault isolation and self-healing networks.
- Inclusion of IoT sensor data for more accurate real-time monitoring and prediction.
- Adoption of deep learning models (e.g., CNNs, LSTMs) for improved fault classification in complex scenarios.
- Scalability to larger power networks with multi-location fault detection and visualization.
- Predictive maintenance capabilities to prevent faults before they occur using historical trends and component health data.

REFERENCES

1. Abhjit Jadhav, Kawita Thakur, “Fault Detection and Classification in Transmission Lines based on Wavelet Transform ”, International Journal of Scientific Engineering and Research (IJSER), 2014.
2. Mamta Patel and R. N. Patel, “Fault Detection and Classification on a Transmission Line using Wavelet Multi Resolution Analysis and Neural Network ”, International Journal of Computer Applications (0975–8887), 2012.
3. Anurag. D. Borkhade, “Transmission Line Fault Detection Using Wavelet Transform ”, International Journal on Recent and Innovation Trends in Computing and Communication.

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