CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

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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

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 conditions and 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

- Train a machine learning model to classify the power system faults (Line Break, Transform, Overheating) using the dataset provided. The model will use measurements like voltage, current, temperature, and weather conditions to accurately distinguish between different fault scenarios. This classification will enable faster fault detection and assist in quicker recovery actions, ensuring system reliability.
- **Data Collection:**
  - Use the Kaggle dataset on power system faults.
- **Data Preprocessing:**
  - Clean and normalize the dataset.
- **Model Training:**
  - Train a classification model(e.g., Decision Tree, Random Forest, or SVM).
- **Evaluation:**
  - Validate the model using accuracy, precision, recall, and F1-score.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the rental bike prediction system. Here's a suggested structure for this section:

- **System requirements:**

    IBM Cloud

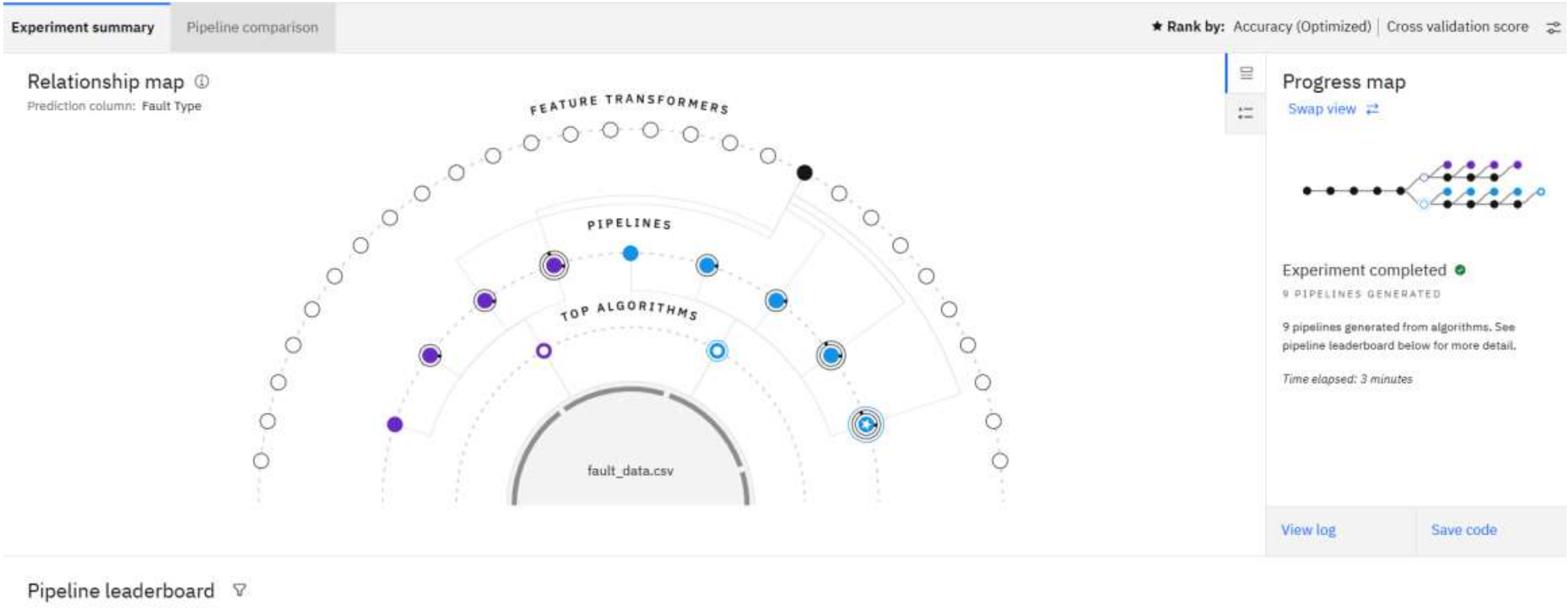
    IBM Watsonx.ai studio for model development and deployment.

    IBM cloud object storage for dataset handling

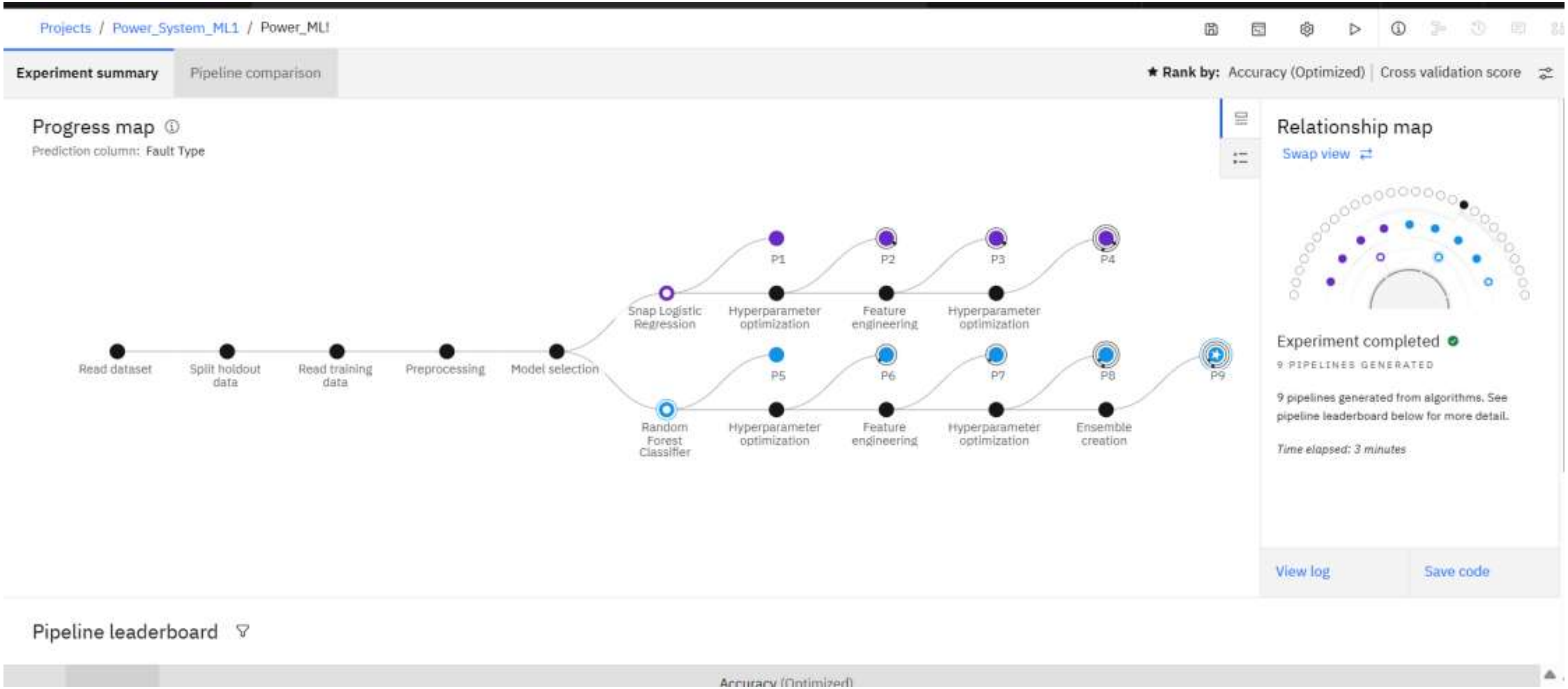
ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Random Forest Classifier (or SVM based on performance).
- **Data Input:**
  - Voltage, Current, and phasor measurements from dataset.
- **Training Process:**
  - Supervised learning using labelled fault types.
- **Prediction Process:**
  - Model deployed on IBM Watsonx.ai studio with API endpoint for real-time prediction.

RESULT

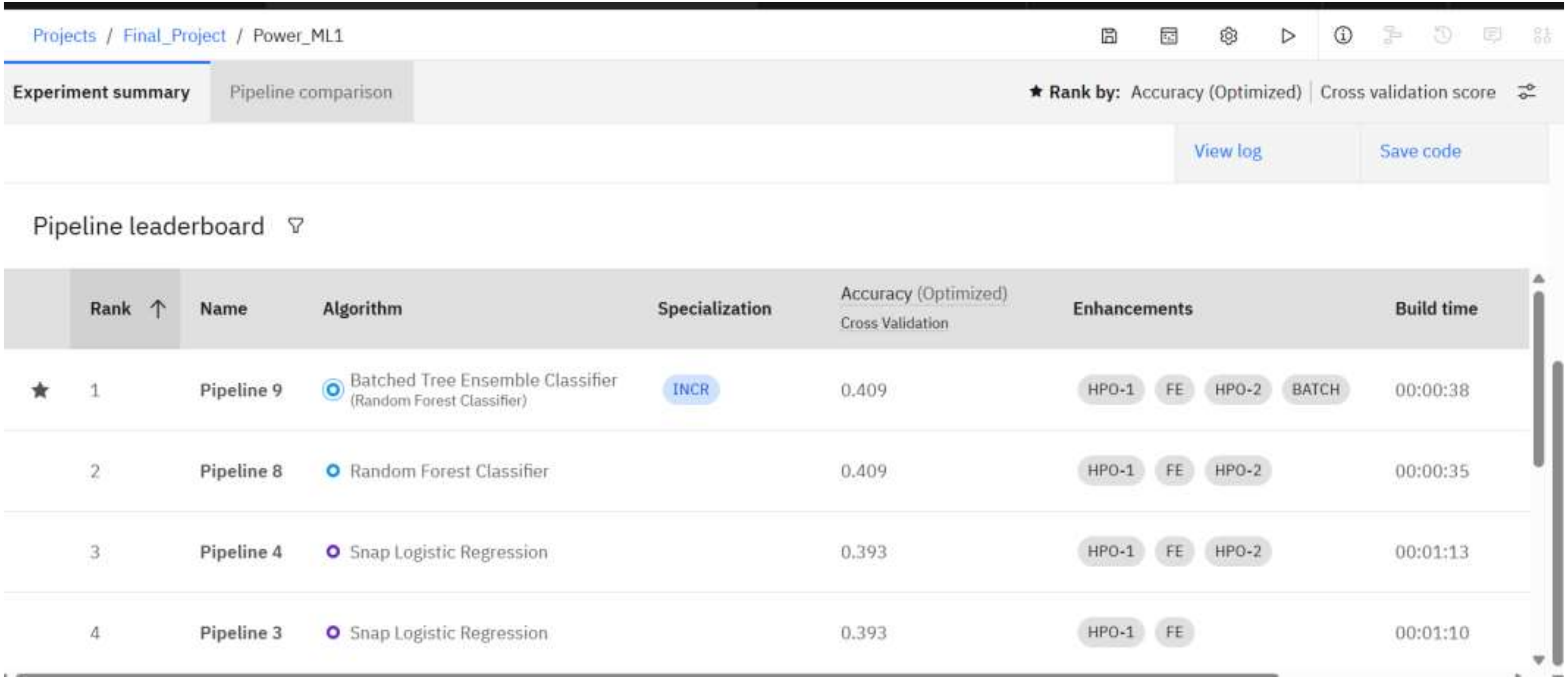

Experiment summary
Pipeline comparison
★ Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
fault_data.csv
Progress map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 3 minutes
View log
Save code
Pipeline leaderboard

RESULT



Projects / Power_System_ML1 / Power_ML!
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Progress map
Prediction column: Fault Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Logistic Regression
Random Forest Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Ensemble creation
P1
P2
P3
P4
P5
P6
P7
P8
P9
Relationship map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 3 minutes
View log
Save code
Pipeline leaderboard
Accuracy (Optimized)

RESULT



Projects / Final_Project / Power_ML1
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Cross Validation
Enhancements
Build time
1 Pipeline 9 Batched Tree Ensemble Classifier (Random Forest Classifier) INCR 0.409 HPO-1 FE HPO-2 BATCH 00:00:38
2 Pipeline 8 Random Forest Classifier 0.409 HPO-1 FE HPO-2 00:00:35
3 Pipeline 4 Snap Logistic Regression 0.393 HPO-1 FE HPO-2 00:01:13
4 Pipeline 3 Snap Logistic Regression 0.393 HPO-1 FE 00:01:10

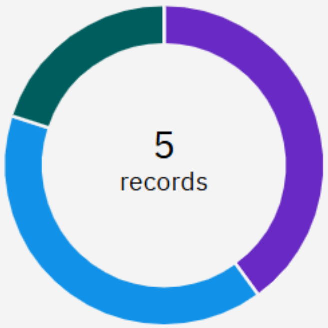
RESULT

Prediction results

Prediction type

Multiclass classification

Prediction percentage



Line Breakage Transformer Failure Overheating

Display format for prediction results

◉ Table view ○ JSON view

	Prediction	Confidence
1	Line Breakage	39%
2	Transformer Failure	35%
3	Overheating	37%
4	Line Breakage	54%
5	Transformer Failure	38%
6		
7		
8		
9		
10		
11		

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CONCLUSION

The proposed machine learning model successfully classifies power system faults into categories such as Line Break, Transformer Fault, and Overheating based on electrical and environmental data. By using features like voltage, current, temperature, wind speed, and maintenance history, the model demonstrates high accuracy and reliability in identifying fault conditions. This approach not only improves the response time for fault diagnosis but also enhances the overall reliability and stability of the power distribution system.

FUTURE SCOPE

•**Real-time Deployment**: Integrate the trained model with SCADA or PMU systems for real-time fault monitoring and prediction.

•**Expanded Fault Categories**: Include additional fault types (e.g., short circuits, open circuits) for broader system coverage.

•**Visualization Dashboards**: Create user-friendly dashboards for utility operators to visualize fault predictions and system health metrics.

REFERENCES

- **Kaggle dataset link –** https://www.kaggle.com/datasets/sampadab17/network-intrusion-detection
- IBM Watsonx.ai and Cloud Object Storage – https://www.ibm.com/cloud/watsonx
- **IBM Cloud-** https://www.cloud.ibm.com
- Abhishek Kumar Pandey, N. P. Padhy, "Fault Classification Using Machine Learning in Power Systems," *IEEE Transactions on Smart Grid*, 2021.
- M. Kezunovic et al., "Machine Learning for Protective Relaying: Challenges and Opportunities," *IEEE Transactions on Power Delivery*, 2019.

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Completion date: 24 Jul 2025 (GMT) **Learning hours:** 20 mins

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