CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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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

Develop a machine learning model that classifies power system faults using the dataset provided. The model will process electrical measurements to identify the type of fault rapidly and accurately. This classification will help automate fault detection and assist in quicker recovery actions, ensuring system reliability.

Key components:

- Data Collection : Use the Kaggle dataset on power system faults. Additional real-time or simulated data can be integrated for better generalization.
- Preprocessing : Clean and normalize the dataset. Handle missing values, encode categorical data, and perform feature selection or extraction to improve model performance.
- Model Training : Train a classification model (e.g., Decision Tree, Random Forest, or SVM). Experiment with multiple algorithms to compare performance.
- Hyperparameter Tuning : Use techniques like Grid Search or Random Search to optimize model parameters and improve accuracy.
- Evaluation :Validate the model using metrics like accuracy, precision, recall, F1-score, and confusion matrix. Perform cross-validation for reliable results.
- Deployment :Deploy the trained model using a web-based dashboard or an API to enable real-time fault classification in practical scenarios.

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SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the power system fault detection and classification. Here's a suggested structure for this section:

System requirements:

IBM Cloud (mandatory)

IBM Watson Studio for model development and deployment

IBM Cloud Object Storage for dataset handling

ALGORITHM & DEPLOYMENT

Algorithm Selection

Begin with the Random Forest Classifier for its robustness and ability to handle non-linear data. Optionally evaluate Support Vector Machine (SVM) or other models (e.g., XGBoost, Logistic Regression) based on accuracy, precision, and computational efficiency

- Data Input Features

Extract and feed relevant electrical measurements such as:

Voltage levels

Current magnitudes

Phasor angles :Feature engineering may also be applied to improve model performance.

- Training Process

Perform supervised learning using a labeled dataset of fault types. Steps include:

Splitting data into training and testing sets

Applying cross-validation

Fine-tuning hyperparameters for best results

ALGORITHM & DEPLOYMENT

- Model Evaluation

Assess performance using metrics like:

Accuracy

Precision

Recall

F1-Score

Use a confusion matrix to understand misclassification.

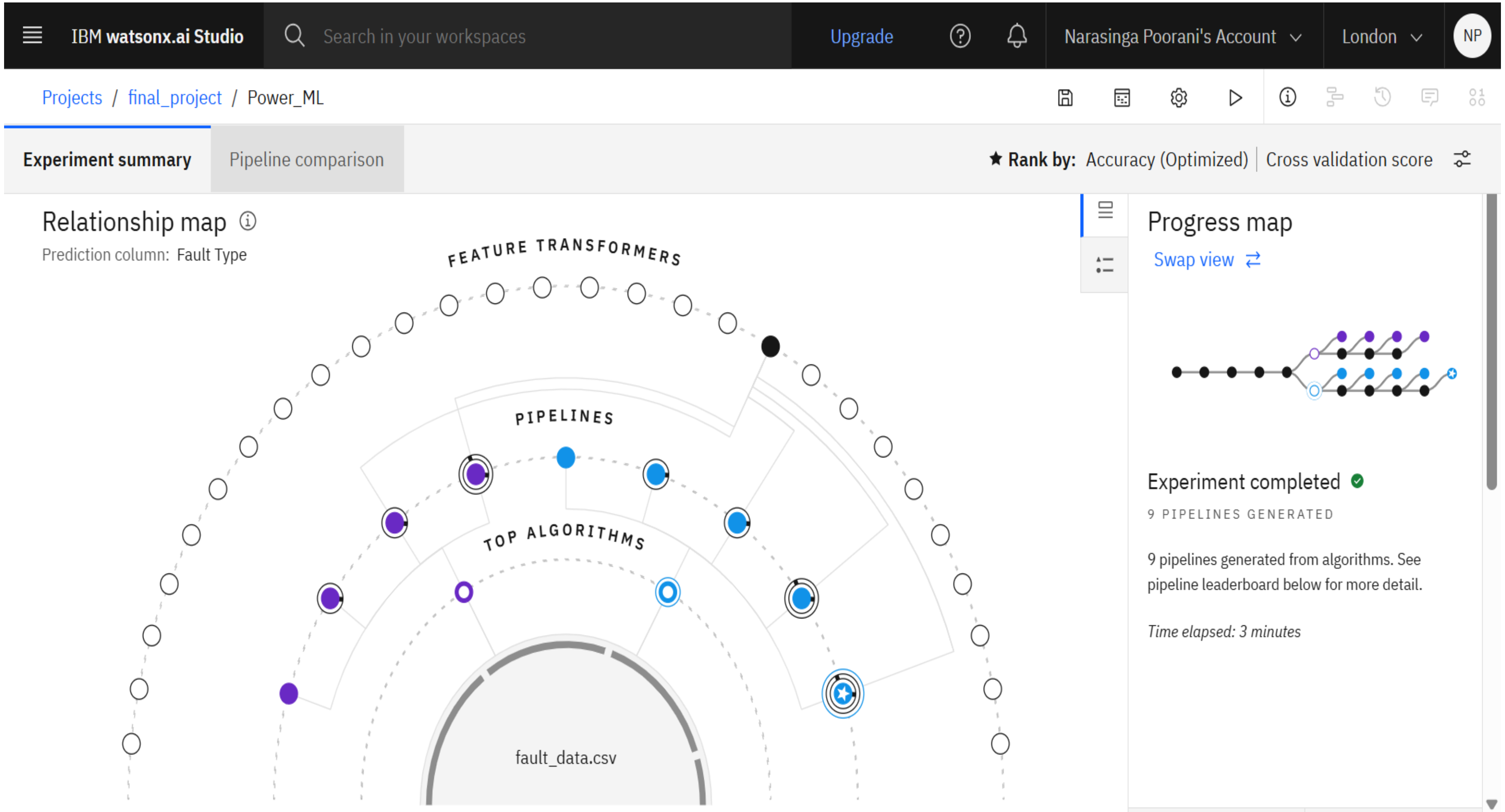
Deployment Strategy:

Deploy the trained model on IBM Watson Studio.

- Enable real-time predictions through an API endpoint
- Use IBM Cloud Object Storage for continuous data access
- Secure the API with appropriate authentication for production use

RESULT

SETTING UP :



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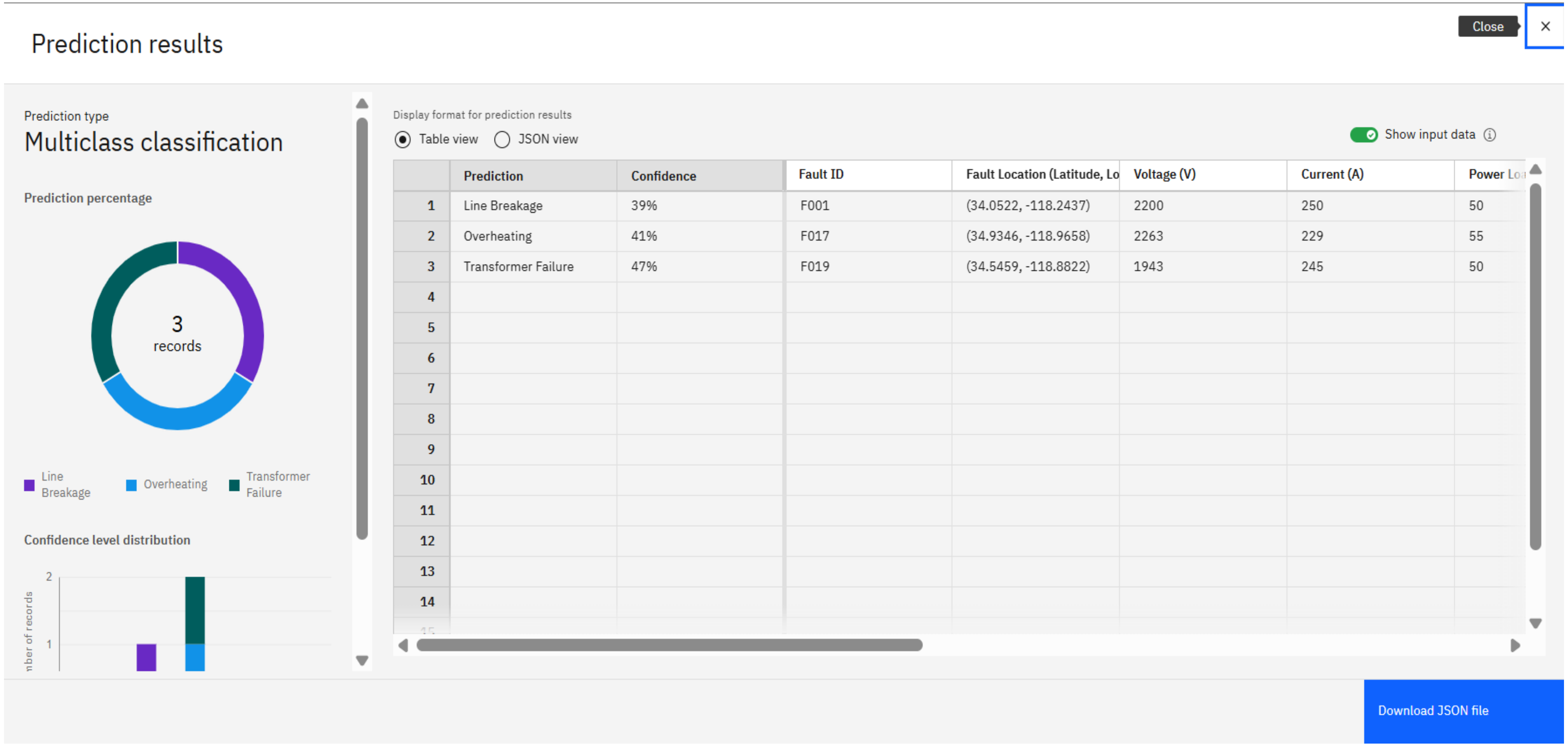
RESULT

DATA INSERTED:

Fault ID	Fault Type	Fault Loca	Voltage (V	Current (A	Power Loa	Temperatu	Wind Spee	Weather C	Maintenan	Compone	Duration c	Down time (hrs)
F001	Line Break	(34.0522, -	2200	250	50	25	20	Clear	Scheduled	Normal	2	1
F002	Transform	(34.056, -1	1800	180	45	28	15	Rainy	Complete	Faulty	3	5
F003	Overheati	(34.0525, -	2100	230	55	35	25	Windstorr	Pending	Overheate	4	6
F004	Line Break	(34.055, -1	2050	240	48	23	10	Clear	Complete	Normal	2.5	3
F005	Transform	(34.0545, -	1900	190	50	30	18	Snowy	Scheduled	Faulty	3.5	4
F006	Overheati	(34.05, -11	2150	220	52	32	22	Thunderst	Pending	Overheate	5	7
F007	Line Break	(34.9449, -	1994	233	51	23	21	Snowy	Complete	Normal	3.7	6.1
F008	Transform	(34.2294, -	2133	229	52	20	18	Snowy	Scheduled	Normal	5.4	2.1
F009	Line Break	(34.1279, -	2155	240	45	21	29	Rainy	Pending	Overheate	3.2	4.7
F010	Line Break	(34.4192, -	2065	199	55	25	21	Clear	Scheduled	Normal	4	2.8
F011	Overheati	(34.3732, -	2118	221	45	20	20	Clear	Complete	Normal	4.9	1.9
F012	Transform	(34.0465, -	2106	247	47	25	13	Clear	Complete	Normal	2.4	6.9
F013	Line Break	(34.9687, -	2012	248	52	24	29	Clear	Complete	Faulty	3.9	6.4
F014	Line Break	(34.3229, -	2289	192	52	35	28	Rainy	Scheduled	Normal	4.1	5.8
F015	Line Break	(34.2256, -	1848	231	49	39	13	Rainy	Scheduled	Faulty	2.7	5
F016	Transform	(34.7105, -	2102	246	53	38	18	Rainy	Complete	Faulty	3.5	1.9
F017	Overheati	(34.9346, -	2263	229	55	21	16	Rainy	Scheduled	Normal	4.5	6

RESULT

PREDICTION RESULT:



CONCLUSION

The project successfully develops a machine learning model to classify power system faults, enabling faster and more reliable fault detection using IBM cloud tools. This approach reduces downtime by quickly identifying faults and increases accuracy compared to manual methods. By using real-time data, the system ensures efficient monitoring and decision-making. Its deployment through IBM Watson Studio makes it easy to scale and integrate. Overall, the solution contributes to building smarter and more stable power systems.

FUTURE SCOPE

This project lays a strong foundation for advanced fault detection in power systems, and there are several possibilities for future enhancement:

1.Integration with Real-Time Grid Data : Connect the model to live power system data for real-time fault monitoring and alerts.

2. Support for More Fault Types : Expand the dataset and model to detect a wider variety of faults, including rare or complex fault conditions.

3. Implementation of Deep Learning :Use deep learning models (e.g., LSTM, CNN) to capture temporal and spatial patterns in power system behavior.

4. Mobile and Web Dashboards : Develop user-friendly interfaces for operators to view predictions, fault history, and system status in real time.

5. Self-Learning Systems : Implement online learning techniques to allow the model to adapt continuously as new data becomes available.

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