# CAPSTONE PROJECT

## POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

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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 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

- The proposed system aims to detect and classify power system faults using machine learning techniques. By analyzing electrical phasor data (voltage and current), the system will accurately identify normal and faulty conditions:
- **Data Collection:**
  - Use the Kaggle dataset containing voltage and current measurements.
  - Include labeled data for various fault types (e.g., LG, LL, LLG, LLL, LLLG, No Fault).
- **Data Preprocessing:**
  - **Clean** data, handle missing values, normalize phasors.
  - Encode fault types as numerical labels.
  - Perform feature extraction to enhance model learning.
- **Machine Learning Algorithm:**
  - Implement algorithms like Random Forest, SVM, or ANN for classification.
  - Train the model to distinguish between fault types based on input features.
- **Deployment:**
  - Use IBM Watson Studio for development.
  - Store data in IBM Cloud Object Storage.
  - Deploy the trained model using Watson Machine Learning with a REST API.
- **Evaluation:**
  - Measure performance using accuracy, precision, recall, and F1-score.
  - Use confusion matrix to analyze prediction quality.

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# SYSTEM APPROACH

The System Approach outlines the methodology and technical strategy used to develop and implement the machine learning model for power system fault detection and classification:

- System requirements
- Hardware:
- Processor: Intel i5/i7 or equivalent
- RAM: 8 GB or more
- Storage: Minimum 2 GB free space
- Internet connectivity (for IBM Cloud)
- Software:
- Operating System: Windows, Linux, or macOS
- IBM Cloud Lite Account (mandatory)
- Python (v3.7+)
- Jupyter Notebook or IBM Watson Studio
- Library required to build the model

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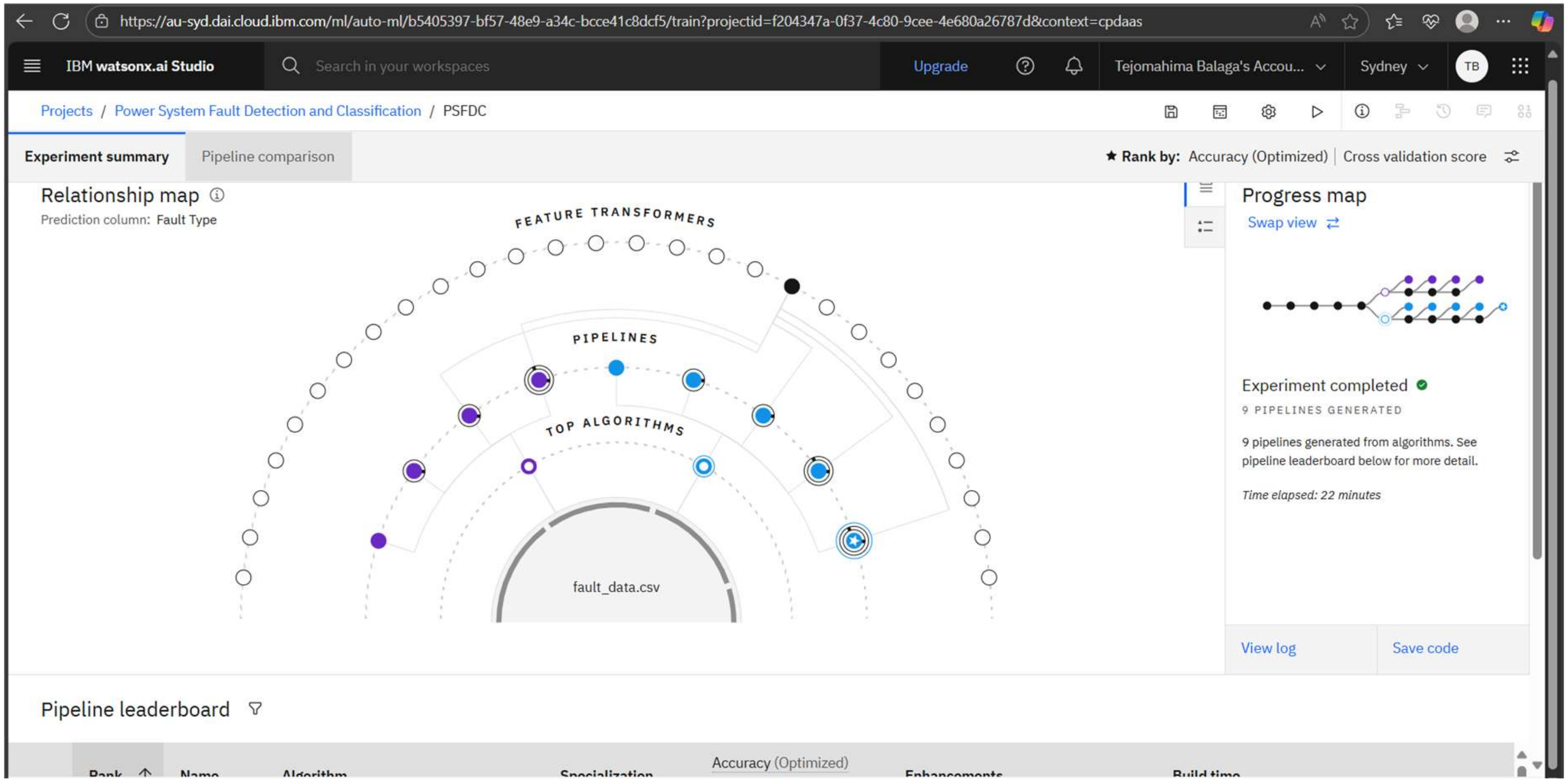
# ALGORITHM & DEPLOYMENT

- In the Algorithm section, describe the machine learning algorithm chosen for predicting faulty type. Here's an example structure for this section:
- **Algorithm Selection:**
  - The **Random Forest Classifier** is used due to its high accuracy, robustness, and ability to handle complex, non-linear relationships in phasor data. It performs well for multi-class classification problems like fault type detection.
- **Data Input:**
- Input features include:
  - Voltage: Va, Vb, Vc
  - Current: Ia, Ib, Ic
    The target output is the **fault type** .
- **Training Process:**
  - Data is cleaned, scaled, and split
  - Labels are encoded
  - Random Forest is traines using cross-validation and optimized using hyperparameter tuning
- **Prediction Process:**
  - The trained model takes real-time phasor data and predicts the fault type.
  - It is deployed on IBM Watson Machine Learning and accessible via a REST API for real-time use in power systems.

# RESULT

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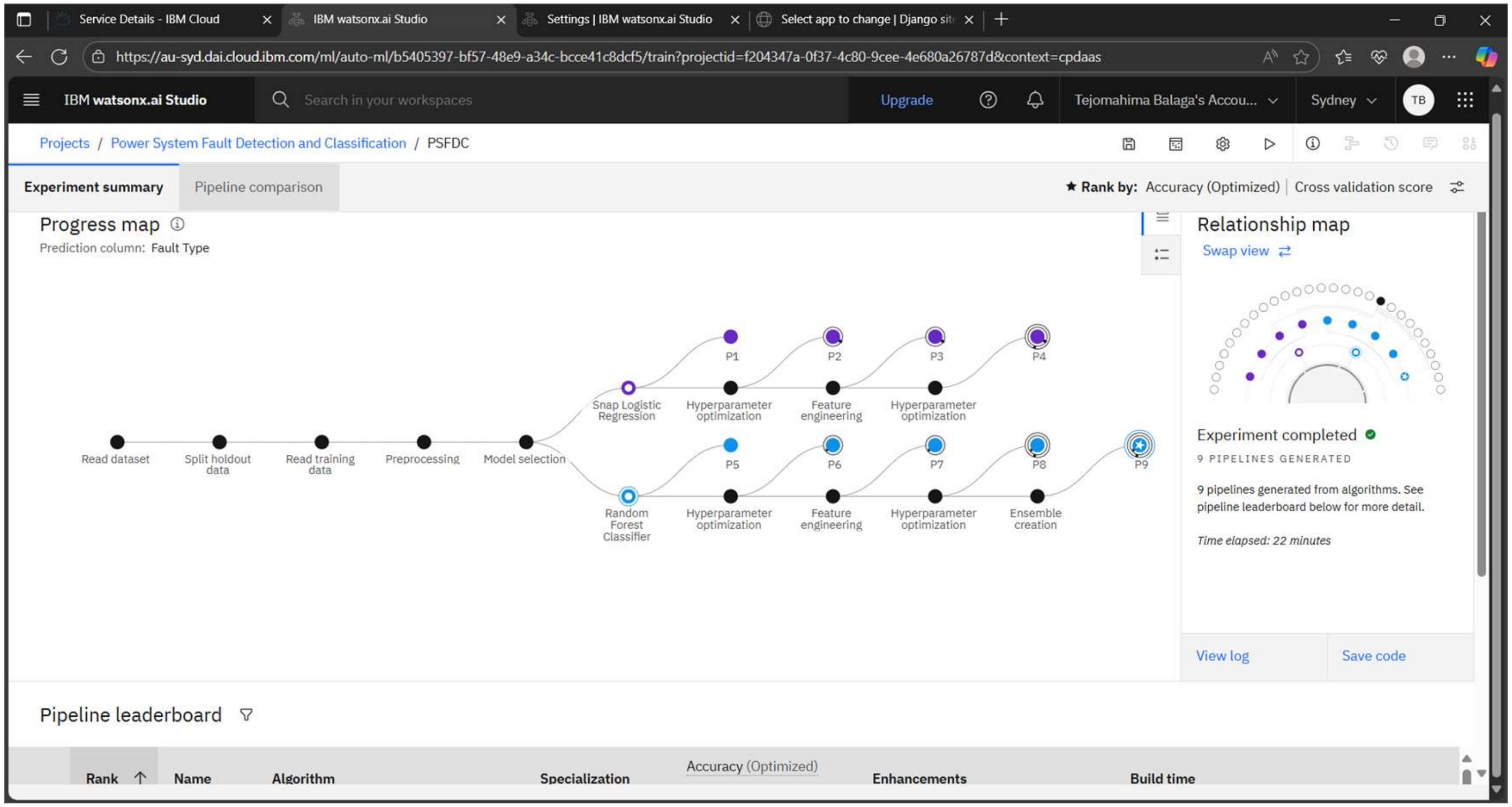
# RESULT


Service Details - IBM Cloud
IBM watsonx.ai Studio
Settings | IBM watsonx.ai Studio
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Search in your workspaces
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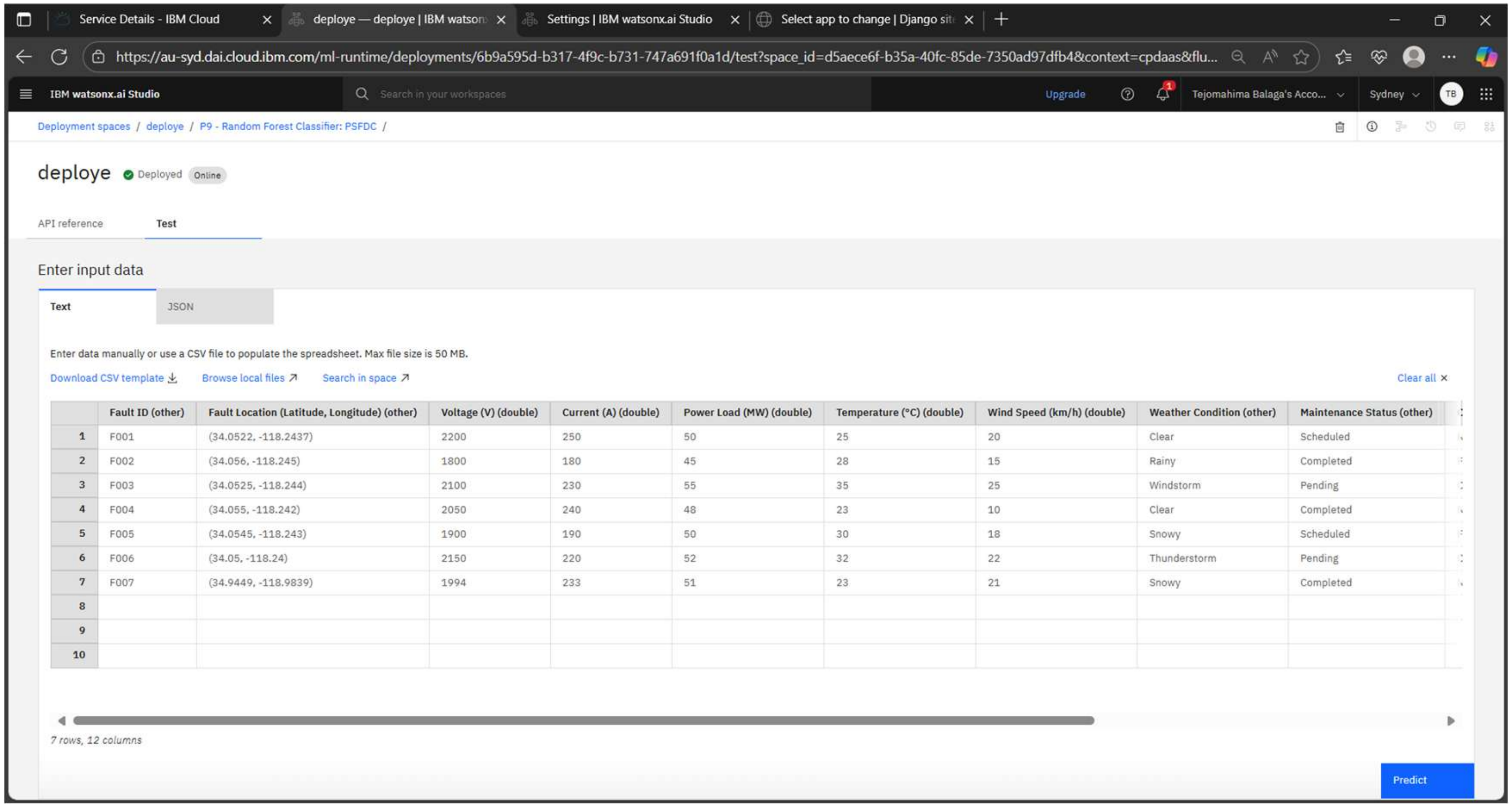
Projects / Power System Fault Detection and Classification / PSFDC
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Progress map
Prediction column: Fault Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Logistic Regression
Random Forest Classifier
Hyperparameter optimization
Feature engineering
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: 22 minutes
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Enhancements
Build time

# RESULT

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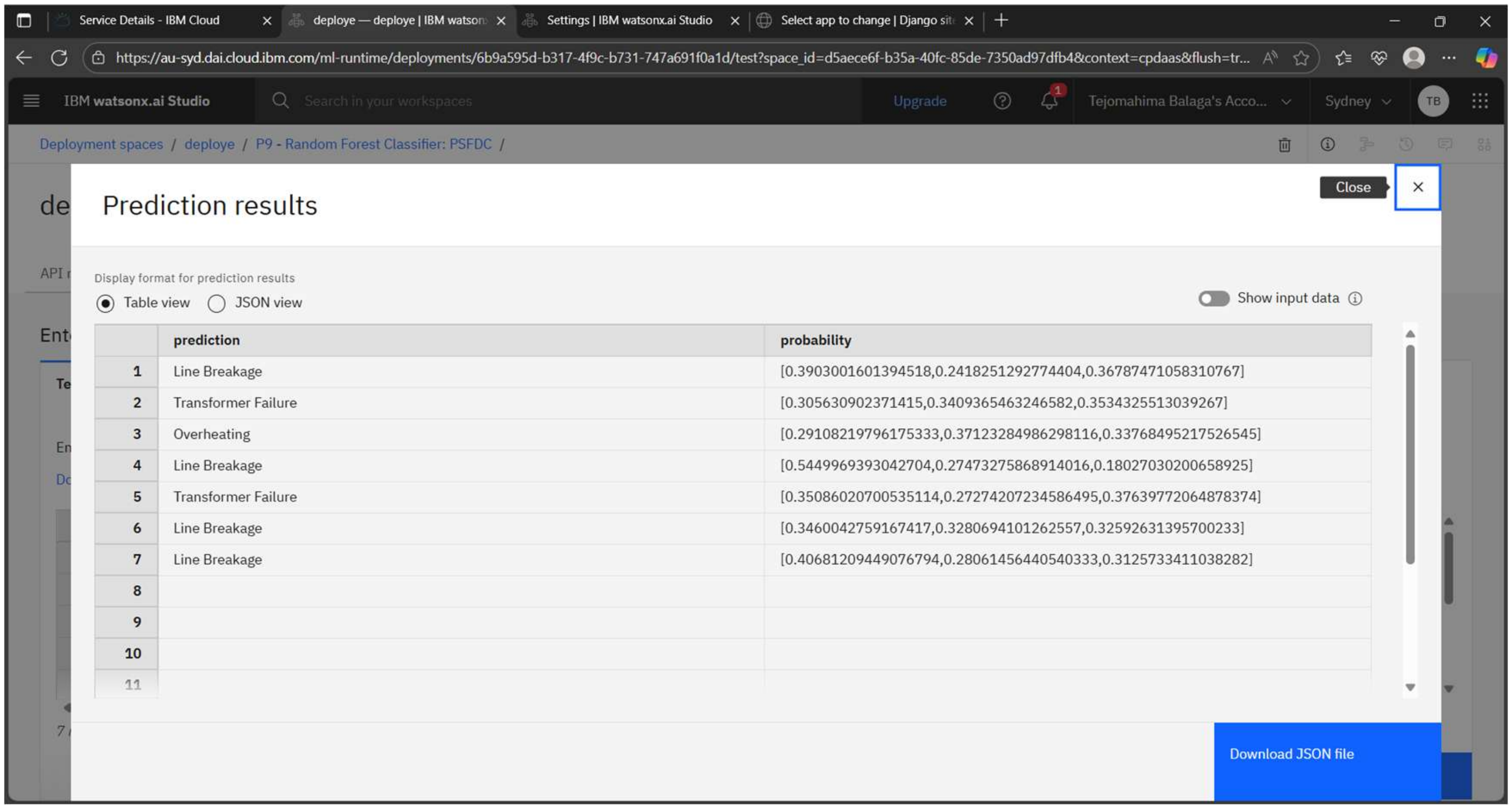
# RESULT


IBM watsonx.ai Studio
Deployment spaces / deploye / P9 - Random Forest Classifier: PSFDC /
Close
Prediction results
Display format for prediction results
Table view
JSON view
Show input data
prediction
probability
1 Line Breakage [0.3903001601394518,0.2418251292774404,0.3678747105831O767]
2 Transformer Failure [0.305630902371415,0.3409365463246582,0.3534325513039267]
3 Overheating [0.2910821979617533 3,0.3712328498629 8116,0.3376849521752 6545]
4 Line Breakage [0.5449969393042704,0.2747327586891 4016,0.1802703020065 8925]
5 Transformer Failure [0.3508602070053511 4,0.2727420723458 6495,0.3763977206487 8374]
6 Line Breakage [0.3460042759167417,0.3280694101262557,0.3259263139570 0233]
7 Line Breakage [0.4068120944907679 4,0.2806145644054 0333,0.3125733411038282]
Download JSON file

# CONCLUSION

- The proposed machine learning-based system effectively detects and classifies various types of faults in a power distribution network using voltage and current phasor data. By employing algorithms like Random Forest and deploying the model on IBM Cloud Lite, the solution ensures fast, accurate, and scalable fault identification. This enhances the reliability, safety, and efficiency of modern power systems, supporting real-time monitoring and quicker fault recovery. The system can be further expanded to integrate real-time sensor inputs and advanced AI models for smart grid applications.

# FUTURE SCOPE

- The developed fault detection and classification system has strong potential for further enhancement:
- Real-time Monitoring Integration: Connect with live sensor or IoT device data for real-time fault detection and automated response.
- Advanced Algorithms: Use deep learning models (e.g., LSTM, CNN) to capture complex patterns and temporal dependencies in phasor data.
- Edge Computing: Deploy models on edge devices (e.g., microcontrollers, smart relays) for on-site fault detection in remote areas.
- Smart Grid Compatibility: Integrate with smart grid infrastructure to support automated control, fault isolation, and self-healing networks.
- Expanded Fault Categories: Extend classification to include more fault types and severity levels for detailed diagnostics.
- Visualization Dashboard: Build a web or mobile dashboard to monitor real-time fault predictions, alerts, and system health.

# REFERENCES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(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

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

Github link:

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# THANK YOU