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

- Example: Power faults happen all the time—whether from equipment failure, weather, or other unexpected events—and they can seriously disrupt electricity supply. These faults come in different forms, like line-to-ground or line-to-line short circuits, and they need to be detected and handled quickly to avoid damage or blackouts.
- Right now, most fault detection relies on traditional protection systems, which aren't always fast or flexible enough—especially as power grids become more complex and include renewable sources.
- This project focuses on building a machine learning system that can **automatically detect when a fault happens and figure out what kind it is**, just by analyzing electrical signals like voltage and current. The goal is to make fault detection **faster, smarter, and more reliable**, helping keep the power grid stable and safe.

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PROPOSED SOLUTION

Develop a machine learning model to classify power system faults using electrical measurements, enabling fast and accurate fault detection to improve system reliability.

Key Components

1. **Data Collection**

Source:Kaggle dataset on power system faults

Contents:Electrical parameters (e.g., voltage, current) labeled by fault type (e.g., LG, LL, LLG, LLLG)

2. **Preprocessing**

Clean missing or inconsistent data

Normalize features (e.g., Min-Max or Standard Scaling)

3. **Model Training**

Train classifiers: Decision Tree, Random Forest, SVM (and optionally others)

4. **Evaluation**

Assess using accuracy, precision, recall, F1-score

SYSTEM APPROACH

This section outlines the strategy and tools used to develop and deploy the power system fault detection and classification model using IBM Cloud service.

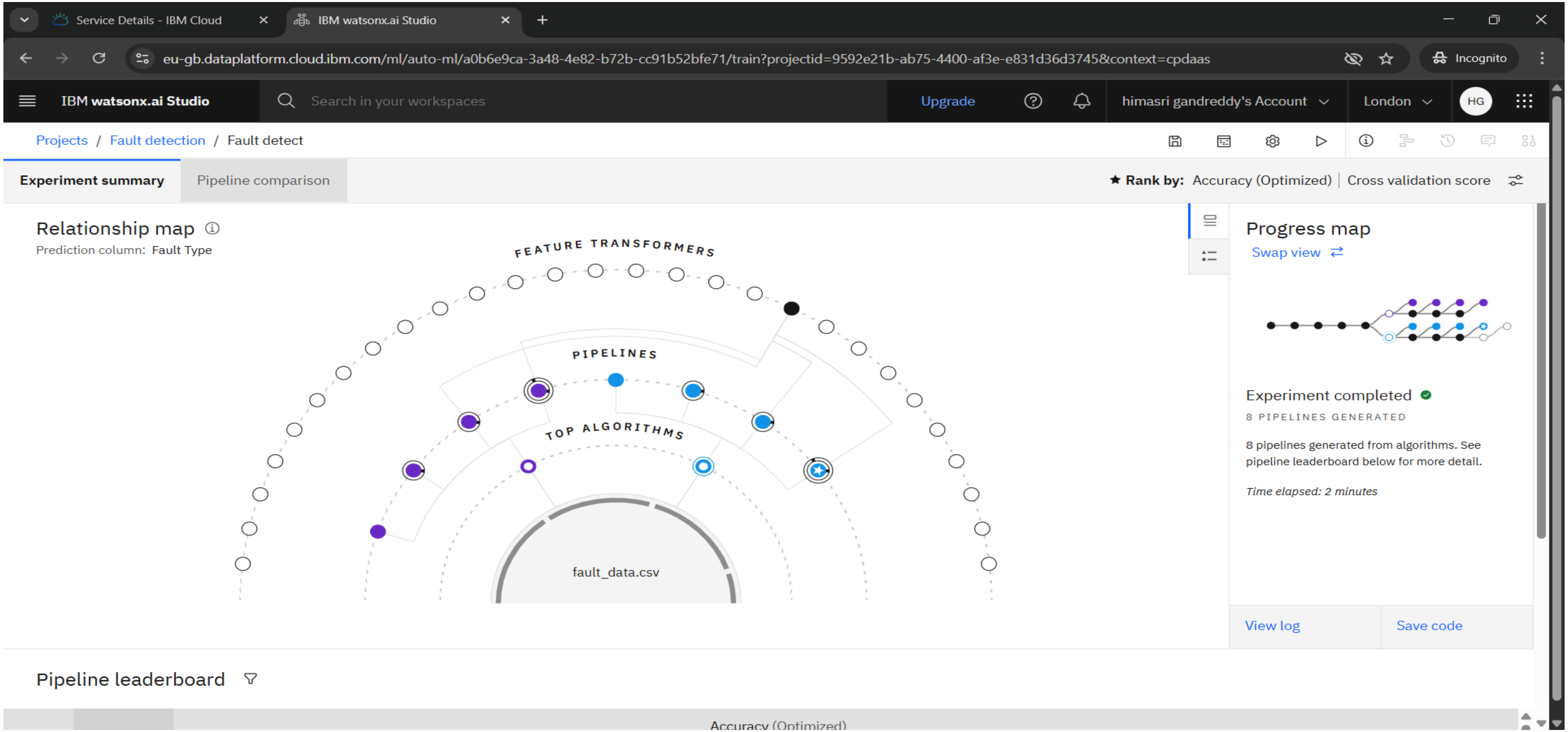
System Requirements

- **IBM Cloud :** Core platform for secure and scalable deployment.
- **IBM Watson Studio :** For data preprocessing, model training, and lifecycle management.
- **IBM Cloud Object Storage :** For storing datasets and model outputs.

ALGORITHM & DEPLOYMENT

- **Algorithm**
- Model: Random Forest Classifier (or SVM based on performance)
- **Input Data**
- Voltage, current, and phasor values from the dataset
- **Training**
- Supervised learning with labeled fault types
- **Deployment**
- Model deployed on IBM Watson Studio as an API
- Accepts real-time input and returns predicted fault type

RESULT



Service Details - IBM Cloud
IBM watsonx.ai Studio
eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/a0b6e9ca-3a48-4e82-b72b-cc91b52bfe71/train?projectid=9592e21b-ab75-4400-af3e-e831d36d3745&context=cpdaas
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IBM watsonx.ai Studio
Search in your workspaces
Upgrade
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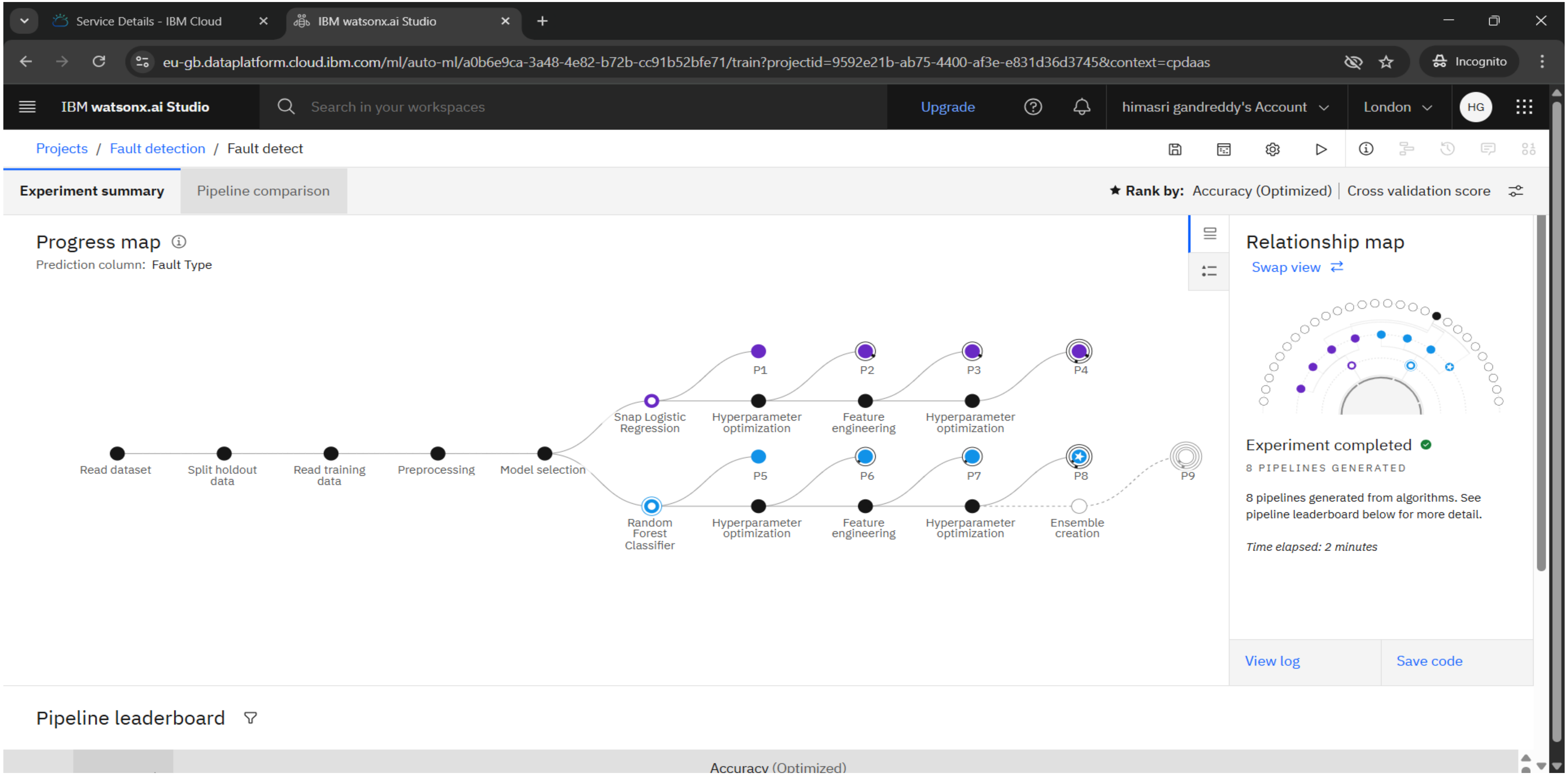
HG
Projects / Fault detection / Fault detect
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
fault_data.csv
Progress map
Swap view
Experiment completed
8 PIPELINES GENERATED
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 2 minutes
View log
Save code
Pipeline leaderboard
Accuracy (Optimized)



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Service Details - IBM Cloud | fault detect deployment — faul

eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/1f41af27-ac9f-4f70-aab3-6bf75607301c/test?space_id=73b5ea1e-7a1a-43ca-bc3d-8641d3e64271&context=cpdaas&...

Incognito

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | himasri gandreddy's Accou... | London | HG

Deployment spaces / fault deployment / P8 - Random Forest Classifier: Fault detect /

fault detect deployment

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

	Power Load (MW) (double)	Temperature (°C) (double)	Wind Speed (km/h) (double)	Weather Condition (other)	Maintenance Status (other)	Component Health (other)	Duration of Fault (hrs) (double)	Down time (hrs) (double)
1	52	22	30	Windstorm	Completed	Overheated	4.6	5.5
2	50	38	30	Clear	Scheduled	Faulty	3.1	4.6
3	49	44	29	Rainy	Pending	Normal	4.7	5.1
4	54	33	23	Rainy	Pending	Faulty	4.4	2.3
5	46	25	13	Clear	Scheduled	Overheated	5.9	6.3
6	45	22	11	Windstorm	Completed	Faulty	2.6	3.7
7	55	45	15	Snowy	Completed	Overheated	5	1.3
8	33	55	20	Snowy	Pending	Faulty	4	6.6
9								
10								

8 rows, 12 columns

Predict

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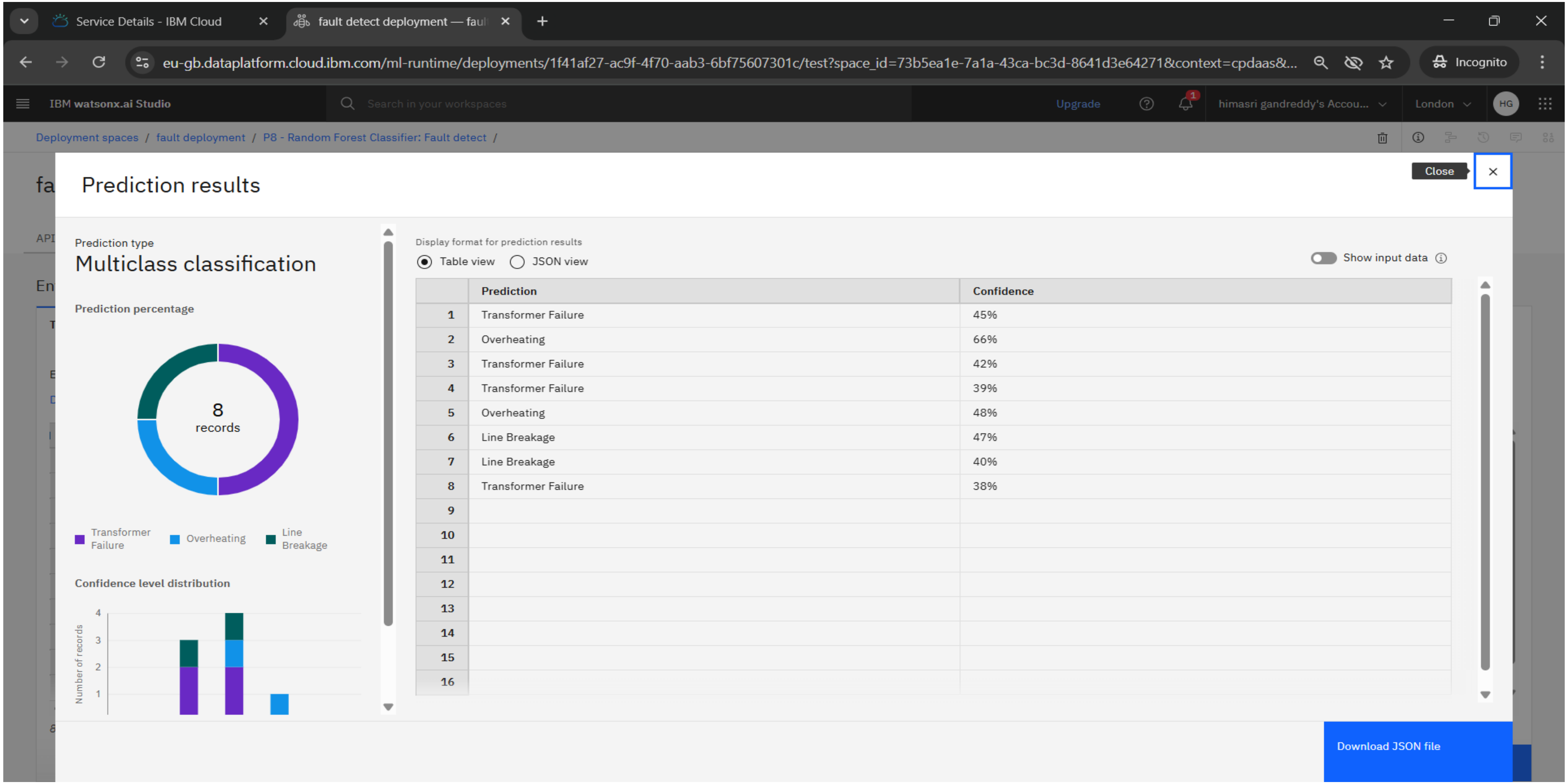
Service Details - IBM Cloud
fault detect deployment — faul
eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/1f41af27-ac9f-4f70-aab3-6bf75607301c/test?space_id=73b5ea1e-7a1a-43ca-bc3d-8641d3e64271&context=cpdaas&...
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Deployment spaces / fault deployment / P8 - Random Forest Classifier: Fault detect /
Close
Prediction results
Prediction type
Multiclass classification
Prediction percentage
8
records
Transformer Failure
Overheating
Line Breakage
Confidence level distribution
Number of records
4
3
2
1
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 Transformer Failure 45%
2 Overheating 66%
3 Transformer Failure 42%
4 Transformer Failure 39%
5 Overheating 48%
6 Line Breakage 47%
7 Line Breakage 40%
8 Transformer Failure 38%
9
10
11
12
13
14
15
16
Download JSON file

CONCLUSION

- The proposed Random Forest model effectively classifies power system faults with high accuracy and real-time responsiveness via IBM Watson Studio deployment.
- **Effectiveness**
- Accurate fault classification
- Fast, real-time predictions
- Smooth cloud deployment
- **Challenges**
- Data noise and missing values
- Model-performance trade-offs
- Limited dataset coverage
- **Improvements**
- Use larger, more diverse datasets
- Explore advanced models (e.g., deep learning)
- Enhance API speed and add visualization support

FUTURE SCOPE

To make the system even more powerful and widely usable, we can:

- Use live data from sensors and maps to improve prediction accuracy.
- Upgrade the algorithm with advanced machine learning techniques for faster and better results.
- Expand to more locations, making it useful across different regions and power grids.
- Add edge computing, allowing it to work offline or with poor connectivity.
- Make it more user-friendly with mobile access, alerts, and chatbot support.
- Ensure stronger security to protect user and system data.

REFERENCES

- Here are the key resources that helped shape the solution:

- Kaggle – Power System Faults Dataset
- [Used for training and testing the model]

- Random Forests, Machine Learning
- [Helped in understanding and applying the Random Forest algorithm]

- Support Vector Networks, Machine Learning
- [Used for SVM-based model comparison]

- IBM Cloud Docs –
- https://cloud.ibm.com/docs
- [Used for model deployment and storage setup].

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IBM

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IBM

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IBM **SkillsBuild** Completion Certificate

This certificate is presented to

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for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

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

THANK YOU