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

- The proposed system will try to solve the problem of identifying different different types of faults in a power management system for easy diagnosis of which problem had occured under given circumstances. To achieve this Machine Learning and Data Analytics are incorporated to identify different types of faults in power management system.
- Data Collection:
  - Gather electrical measurement data including voltage and current phasors.
  - Incorporating operating conditions and various fault conditions, for enhancement of prediction which improves accuracy.
- Data Preprocessing:
  - Preprocess data which contain noise,outlier and other random inconsistencies.
  - Feature extraction is used to identify highly correlated values based on data,which might make a huge impact on our prediction.
- Machine Learning Algorithm:
  - Utilize a Machine Learning Modal for classification(such as random forest classifier,ensembler classification) to classify faults in power management system.
  - Encompass other factors like weather conditions, component health, and other factors during fault to improve prediction.
- Deployment:
  - Develop a easy to use UI interface or application that gives predictions for type of fault encountered with given input parameters.
  - Deploy the solution on a scalable and trustworthy platform, taking in factors like server architecture,, easy to access, and fast response time..
- Evaluation:
  - Evaluate the model's performance encompassing relevant metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), or other relevant metrics.
  - Fine-tune the model based on user feedback and updating it with real time conditional parameters.
  - Result:

SYSTEM APPROACH

System requirements:

IBM Cloud access for using relevant project features

IBM Cloud bucket storage for storing model and hosting it.

Watsonx.ai studio service for ml operation

Library required to build the model:

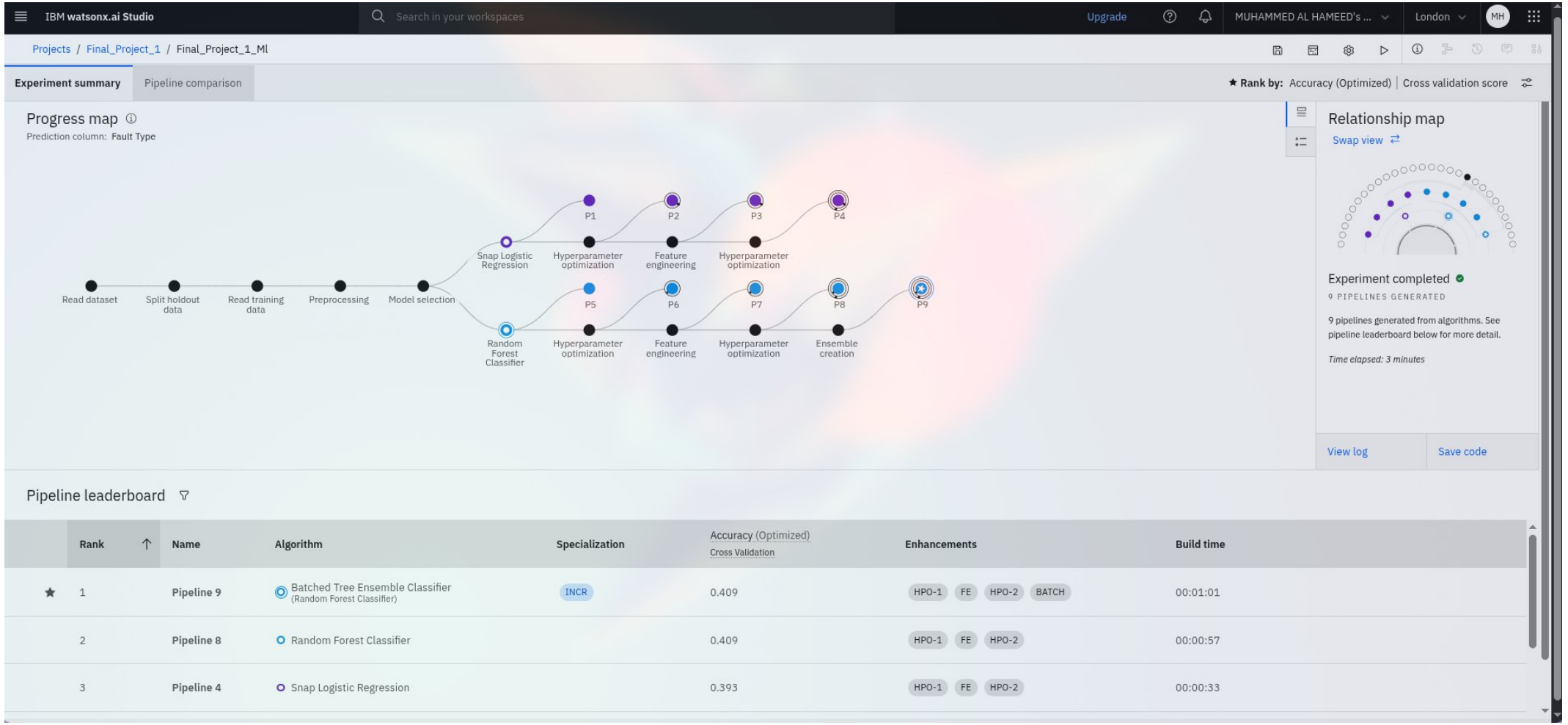
Requests is needed for processing requests from IBM API

Json is needed ,sincelit is aldready in built ,it does not have to be download it externally

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - Ensembler classification is the selected because dataset contain multiple fault types(Line Breakage,Transformer Failure) and a normal class as well.
  - It can encompass many methods like random forest , gradient boosting which is helpful in handling noisy data.
- **Data Input:**
  - The data contains electrical measurement data like Voltage,Current and other general factors like,Component Health. Also general weather conditions inlcuding temperature,wind speed.Weather condition.
- **Training Process:**
  - The algorithm is trained using a preporcessed dataset with cross validation done and hyperparameter tuning by utilizing grid search and randomized search.
- **Prediction Process:**
  - The completely trained algorithm is deployed in IBM cloud with IBM cloud bucket storage. Then the user can enter their given parameters manually and it gives an estimated prediction with certain confidence.

RESULT



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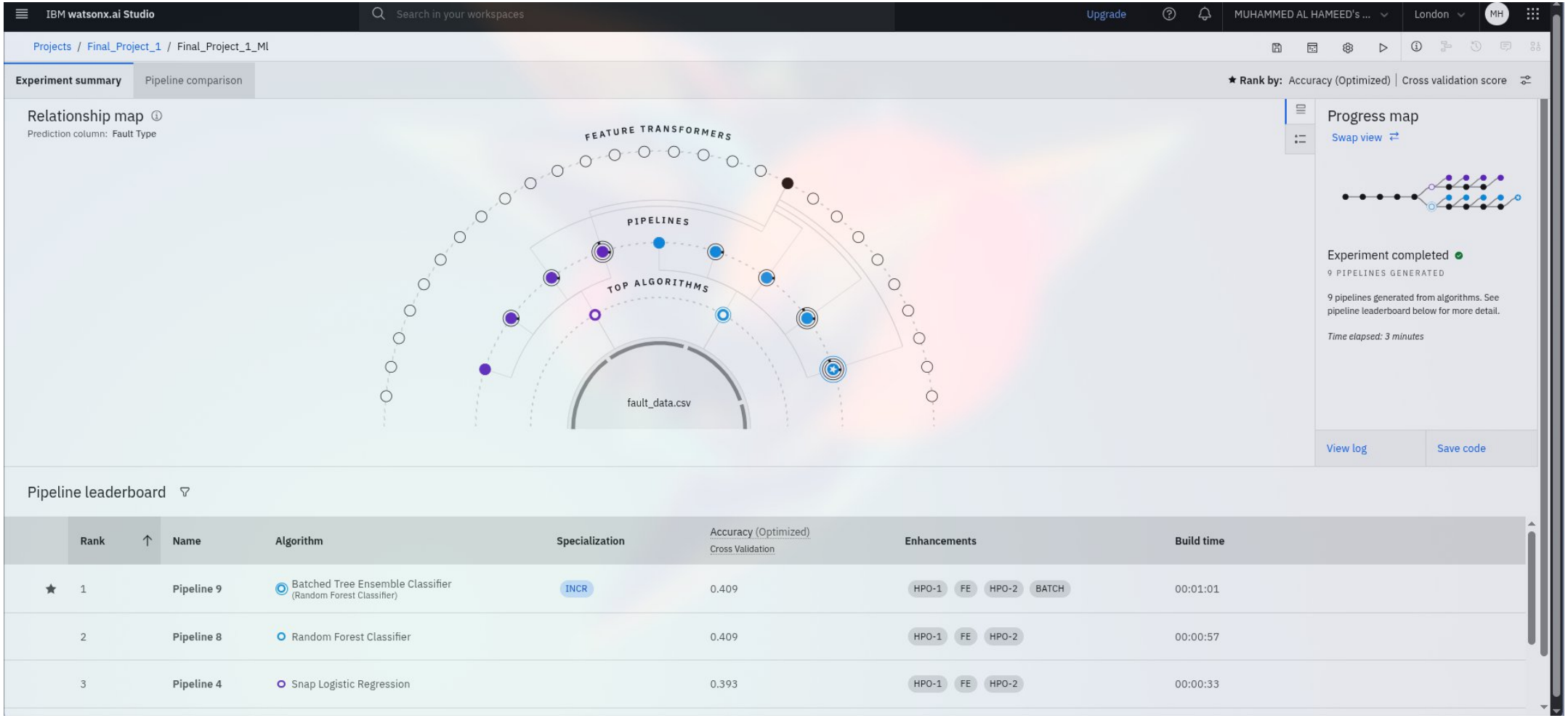
RESULT



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RESULT

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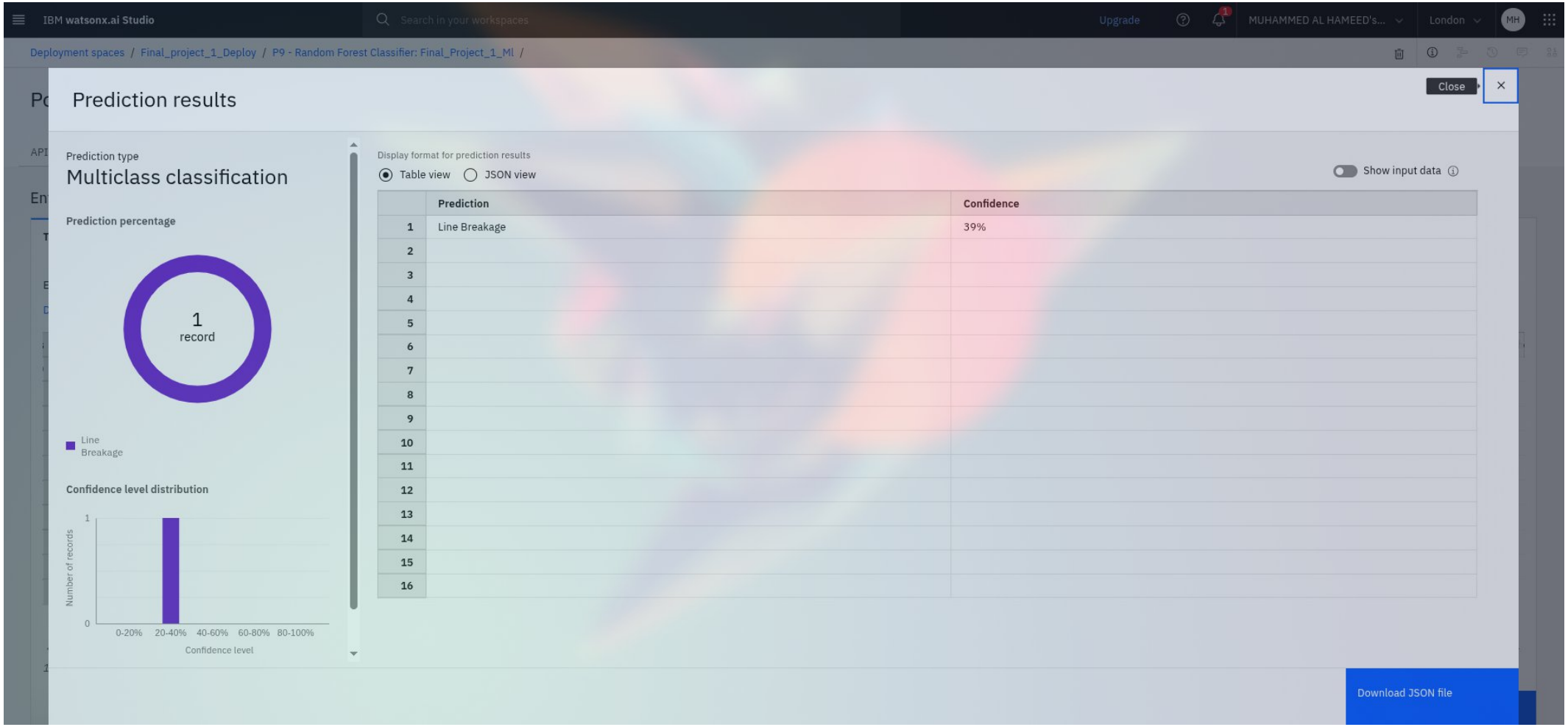
RESULT



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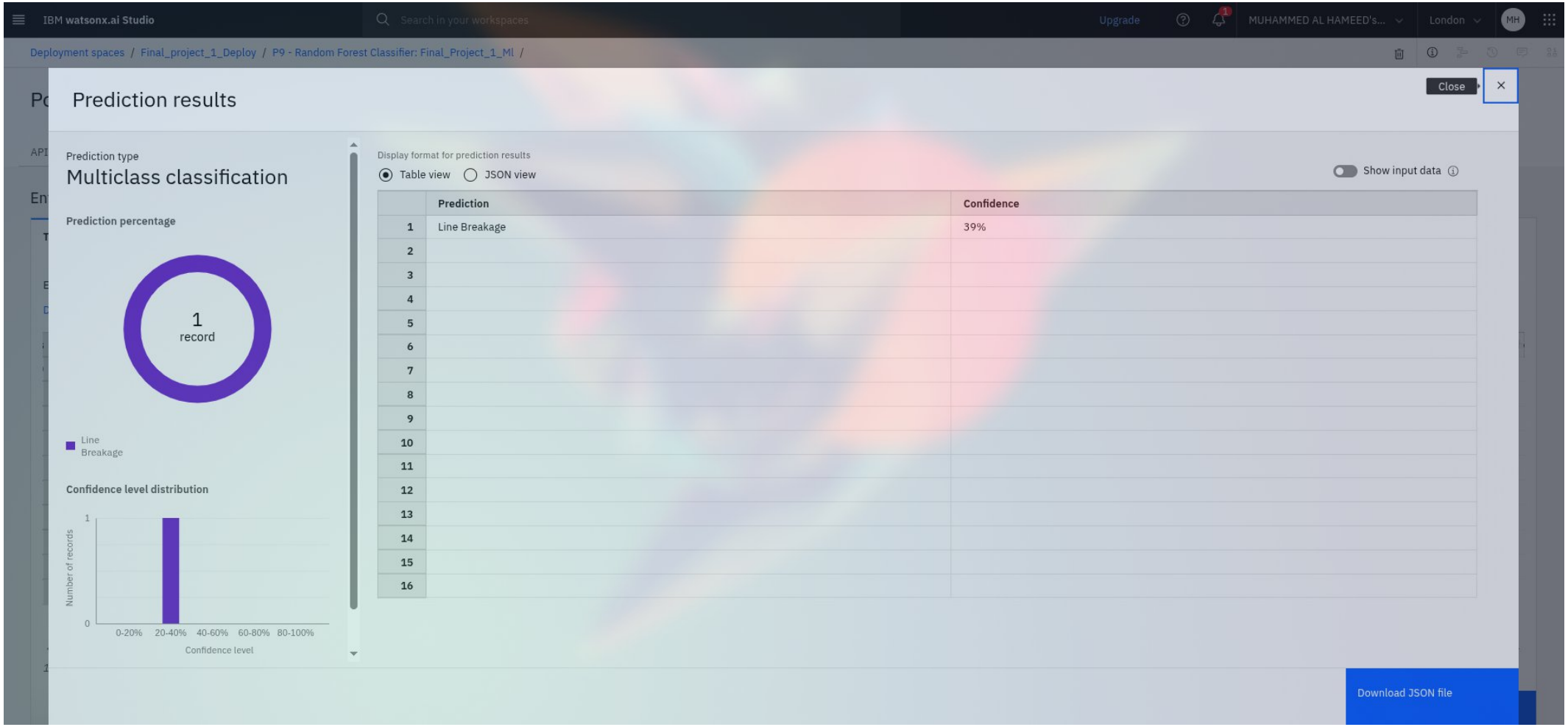
RESULT



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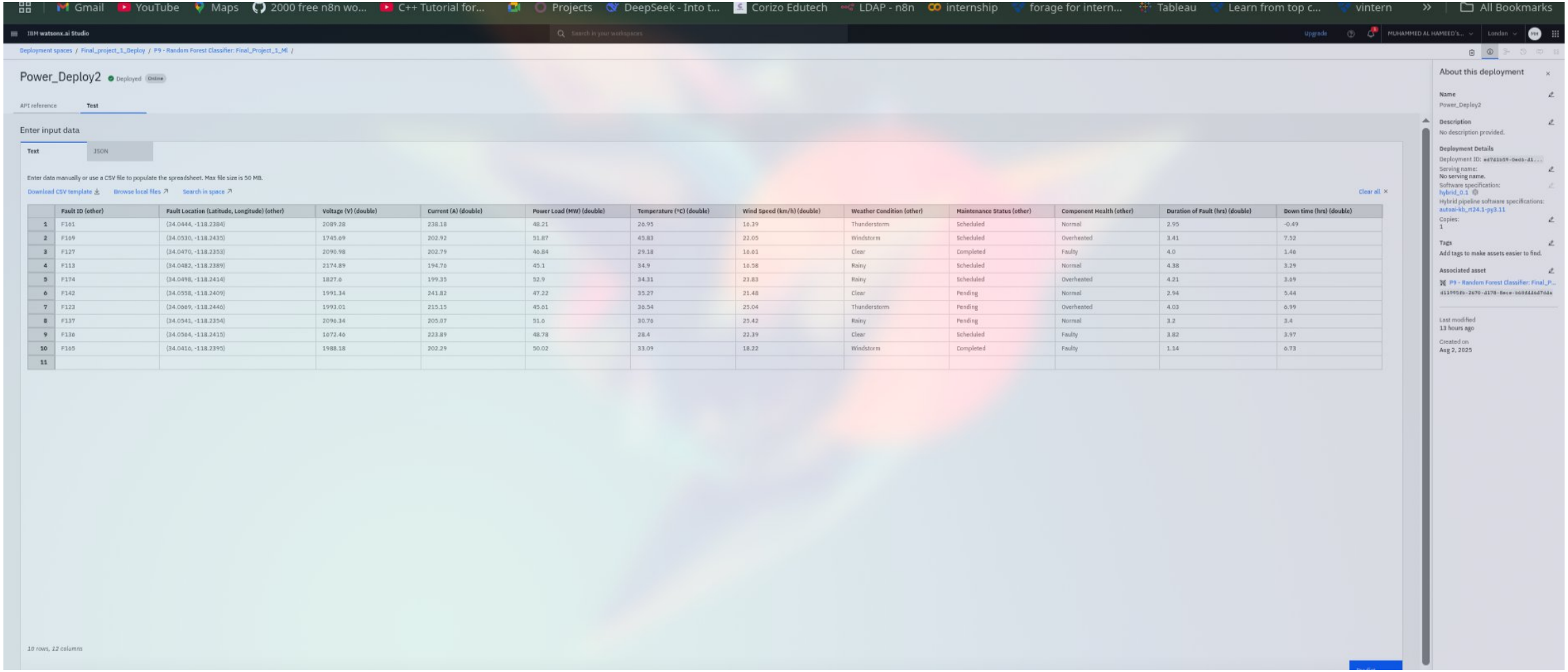
RESULT



	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)	Maintenance Status (other)	Component Health (other)	Duration of Fault (hrs) (double)	Down time (hrs) (double)
1	F161	(34.0444, -118.2384)	2089.28	238.18	48.21	26.95	16.39	Thunderstorm	Scheduled	Normal	2.95	-0.49
2	F169	(34.0530, -118.2435)	1745.09	202.92	51.87	45.83	22.05	Windstorm	Scheduled	Overheated	3.41	7.52
3	F127	(34.0470, -118.2353)	2090.98	202.79	46.84	29.18	16.01	Clear	Completed	Faulty	4.0	1.46
4	F113	(34.0482, -118.2389)	2174.89	194.76	45.1	34.9	16.58	Rainy	Scheduled	Normal	4.38	3.29
5	F174	(34.0498, -118.2414)	1827.6	199.35	52.9	34.31	23.83	Rainy	Scheduled	Overheated	4.21	3.69
6	F142	(34.0558, -118.2409)	1991.34	241.82	47.22	35.27	21.48	Clear	Pending	Normal	2.94	5.44
7	F123	(34.0669, -118.2446)	1993.01	215.15	45.61	36.54	25.04	Thunderstorm	Pending	Overheated	4.03	6.99
8	F137	(34.0541, -118.2354)	2096.34	205.07	51.6	30.76	25.42	Rainy	Pending	Normal	3.2	3.4
9	F136	(34.0564, -118.2415)	1672.46	223.89	48.78	28.4	22.39	Clear	Scheduled	Faulty	3.82	3.97
10	F165	(34.0416, -118.2395)	1988.18	202.29	50.02	33.09	18.22	Windstorm	Completed	Faulty	1.14	6.73
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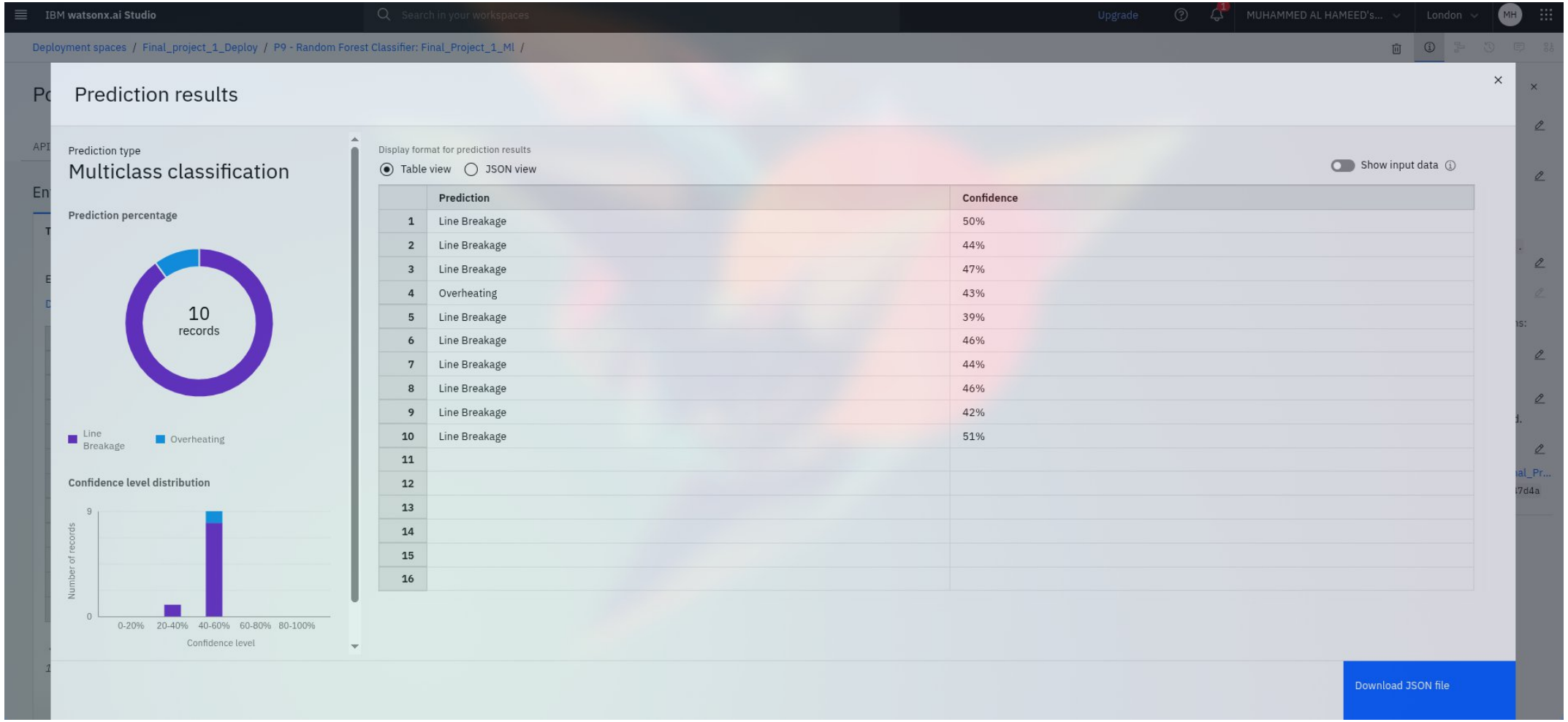
RESULT



CONCLUSION

- The model predicted fault type with a confidence of 51% this suggests there is a lot of room for improvement from checking the data being used to the method being prescribed for this multiclass classification model.
- It qualifies as a decent first attempt with around 5 to 6 types or faults it can still detect with around 50% confidence, its a work in progress.

FUTURE SCOPE

- This can include potential enhancements by utilizing additional data sources as the initial dataset was not enough to train a good model for industry standard and better optimization is also needed for improving the models accuracy it could be done by doing further EDA(exploratory Data analysis) and a confusion matrix to further simplify and better identify highly correlated values and improve this models prediction by improving its accuracy and reducing its loss function , further deep learning models and techniques can also by tried to improve this models performance.

REFERENCES

- Dataset:

Kaggle link:

https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset

- Storage and Machine learning features:

Watsonx.ai documentation:

https://dataplatform.cloud.ibm.com/docs/content/wsj/getting-started/welcome-main.html?context=wx&audience=wdp

Ibm cloud link:

https://cloud.ibm.com/

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