CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION

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OUTLINE

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PROBLEM STATEMENT

Faults in a power distribution system can significantly impact the stability and reliability of the electrical grid. These faults include line-to-ground, line-to-line, and three-phase faults. Traditional methods for fault detection and classification are often time-consuming and require manual interpretation.

The challenge is to design a machine learning model that can detect and classify such faults automatically using electrical measurement data such as voltage and current phasors.

PROPOSED SOLUTION

The proposed system leverages a supervised machine learning model to detect and classify power system faults using features like voltage and current values. The solution includes:

- Data ingestion from a fault dataset (Kaggle)
- Preprocessing and feature extraction
- Training classification models (e.g., Decision Tree, Random Forest, SVM)
- Evaluating model performance
- Deploying the model using IBM Cloud Lite services

SYSTEM APPROACH

System Requirements:

- IBM Cloud (Lite Version)
- Python 3.x
- IBM Watson Studio
- Jupyter Notebook

Libraries Required:

- pandas, numpy, matplotlib, seaborn
- scikit-learn
- IBM Watson Machine Learning SDK

SYSTEM APPROACH

Development Steps:

1. Collect dataset from Kaggle
2. Preprocess and encode the data
3. Select relevant features and apply scaling
4. Train and evaluate machine learning models
5. Deploy the model on IBM Cloud

ALGORITHM & DEPLOYMENT

Algorithm Chosen: Random Forest Classifier

Reason for Selection: Performs well on classification tasks, robust to overfitting, interpretable, handles class imbalance

Input Features:

Phase voltages: Va, Vb, Vc

Phase currents: Ia, Ib, Ic

Target label: Fault type

Training Process:

Train-test split (80:20)

GridSearchCV for hyperparameter tuning

Evaluation metrics: Accuracy, Precision, Recall, F1-score

ALGORITHM & DEPLOYMENT

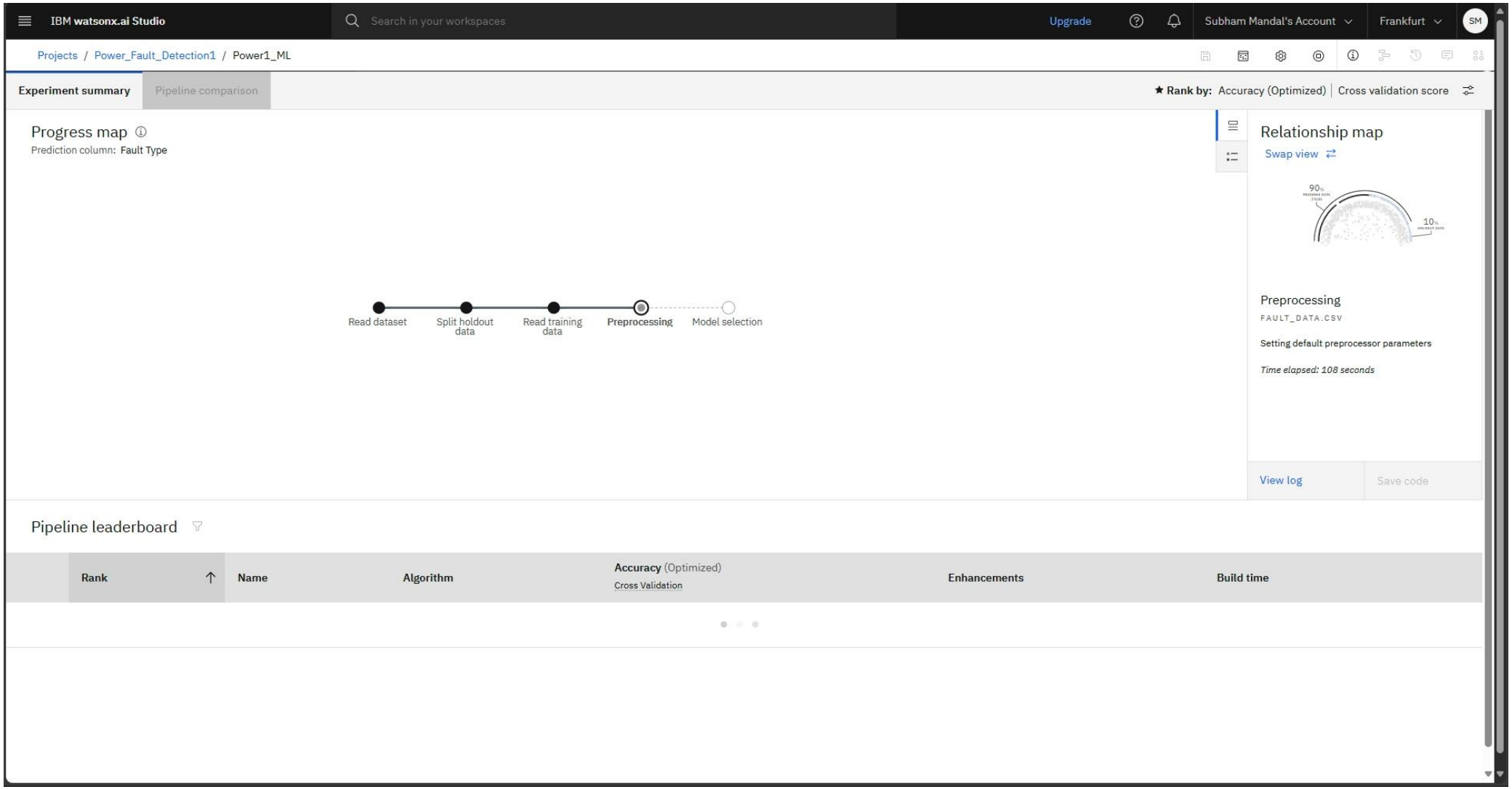
Deployment:

Model saved as .pkl file

Deployed using IBM Watson Machine Learning

API created using IBM Cloud Functions or IBM App Runtime

RESULT



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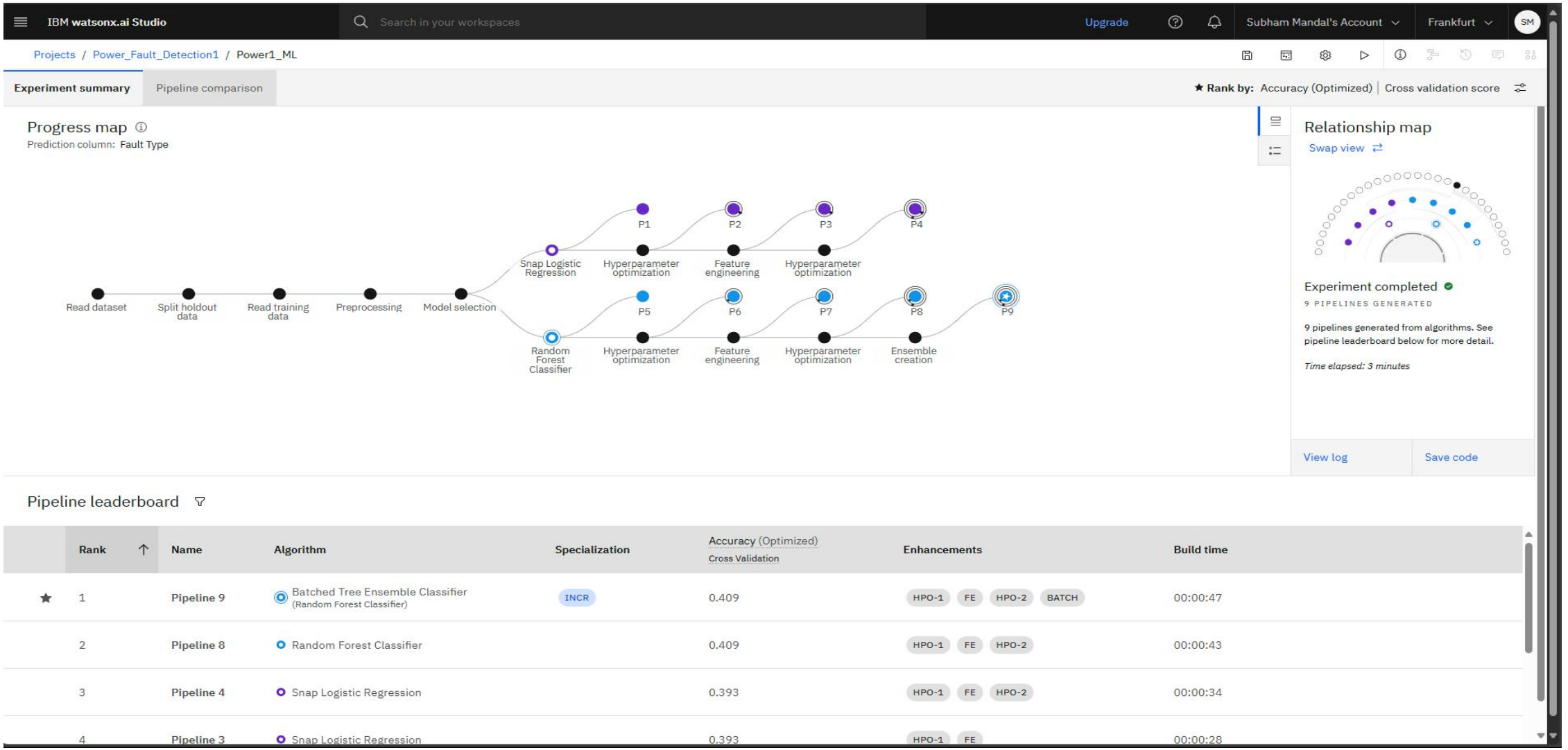
RESULT



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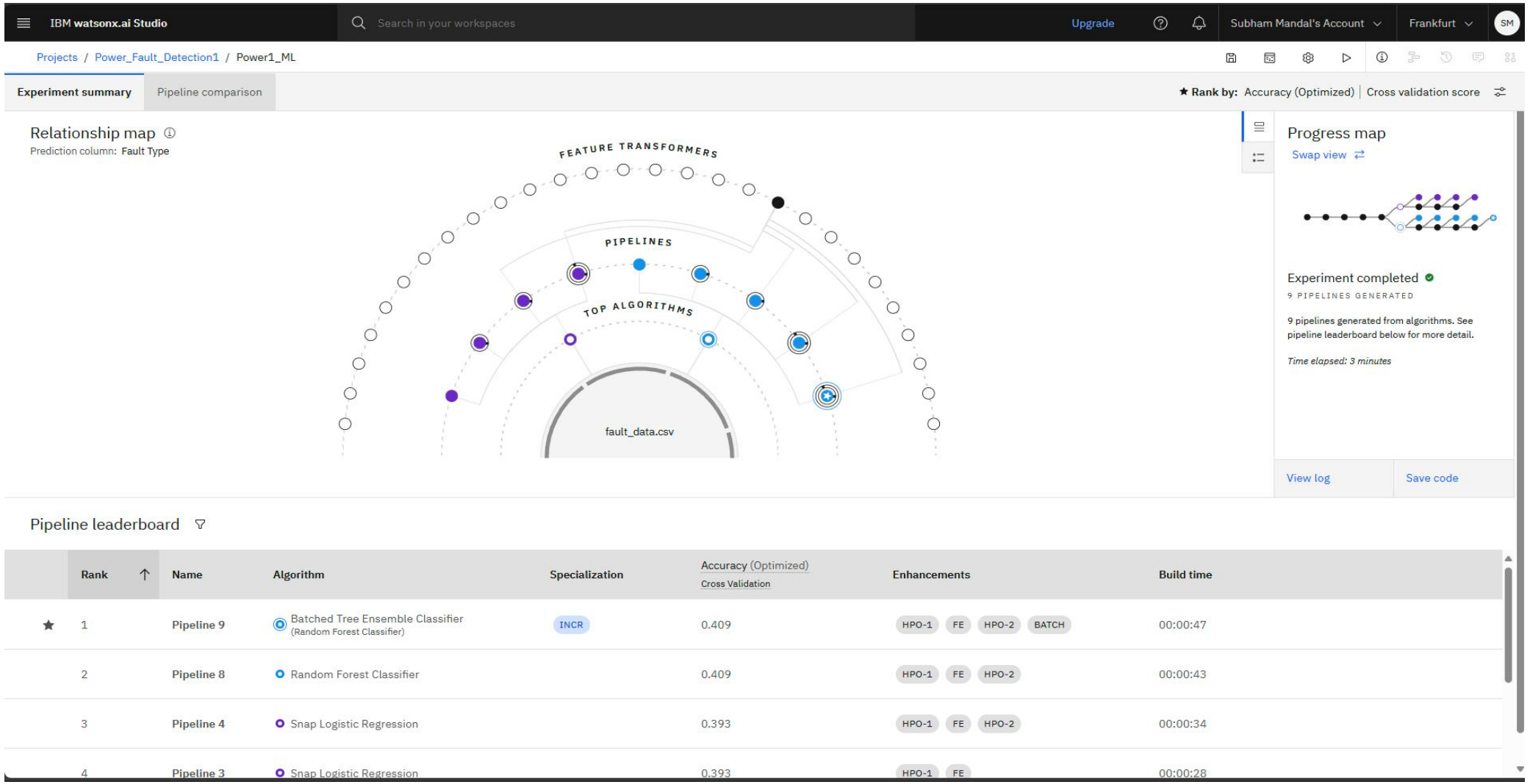
RESULT



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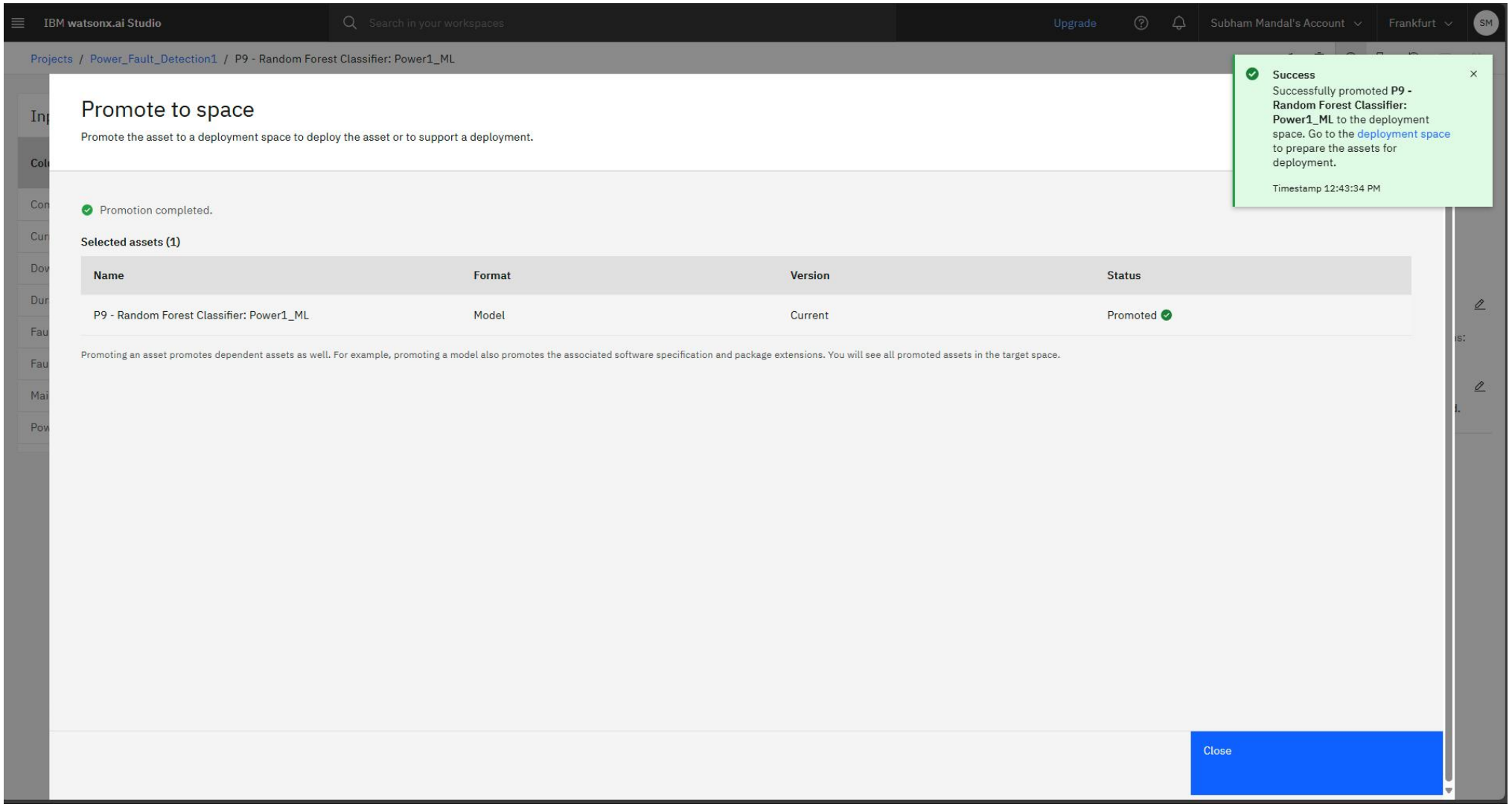
RESULT



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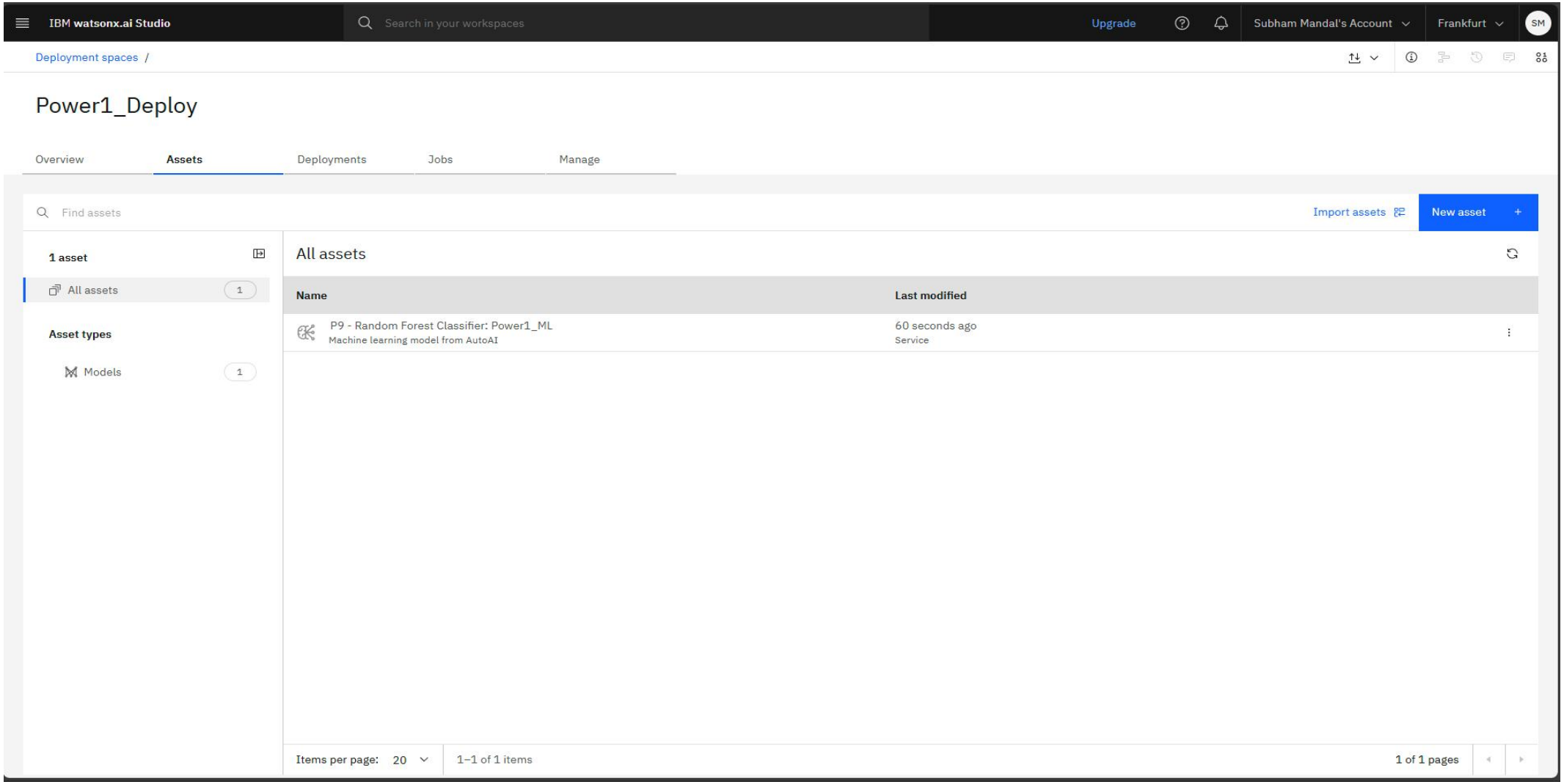
RESULT



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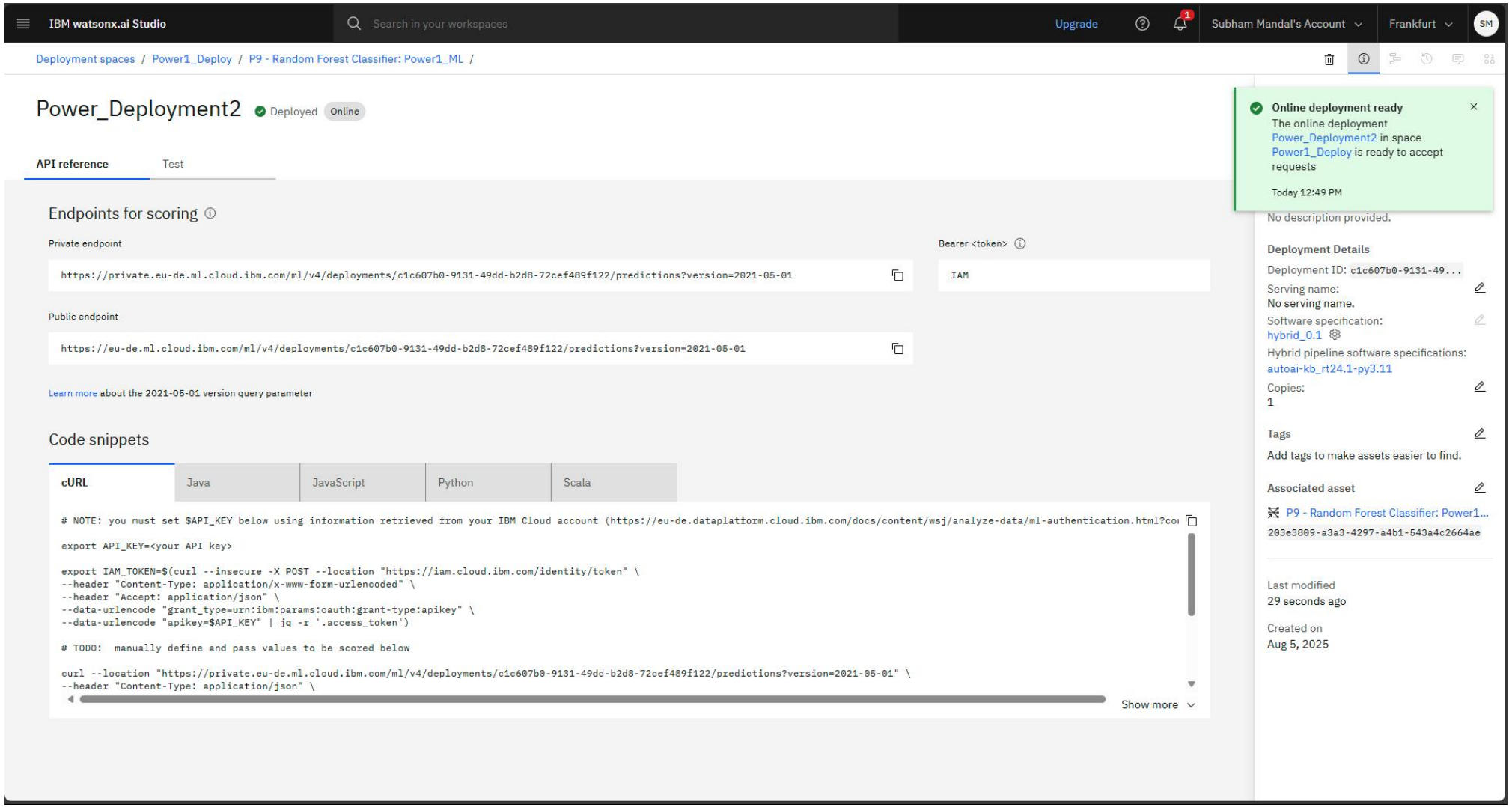
RESULT



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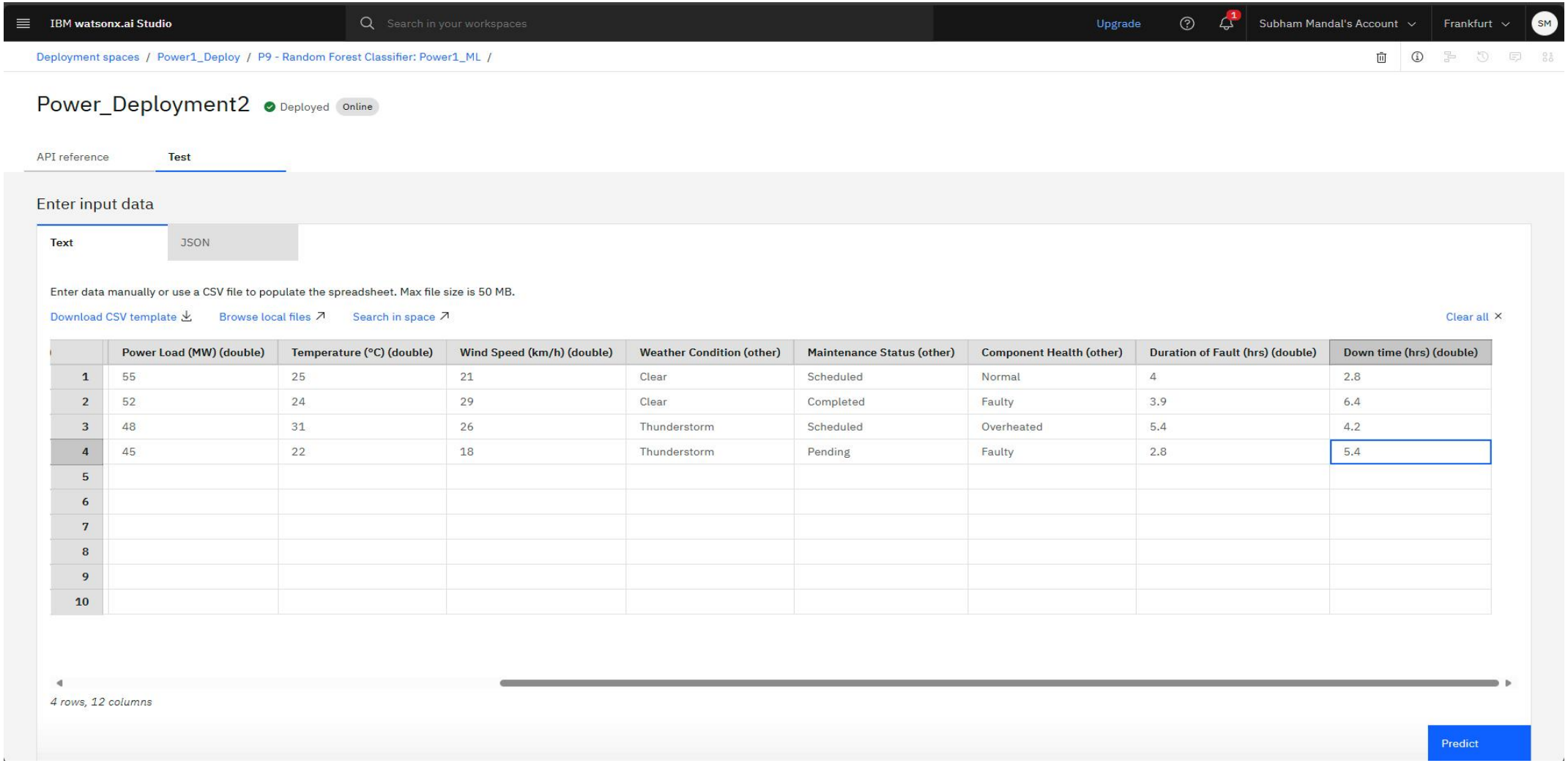
RESULT



	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	55	25	21	Clear	Scheduled	Normal	4	2.8
2	52	24	29	Clear	Completed	Faulty	3.9	6.4
3	48	31	26	Thunderstorm	Scheduled	Overheated	5.4	4.2
4	45	22	18	Thunderstorm	Pending	Faulty	2.8	5.4
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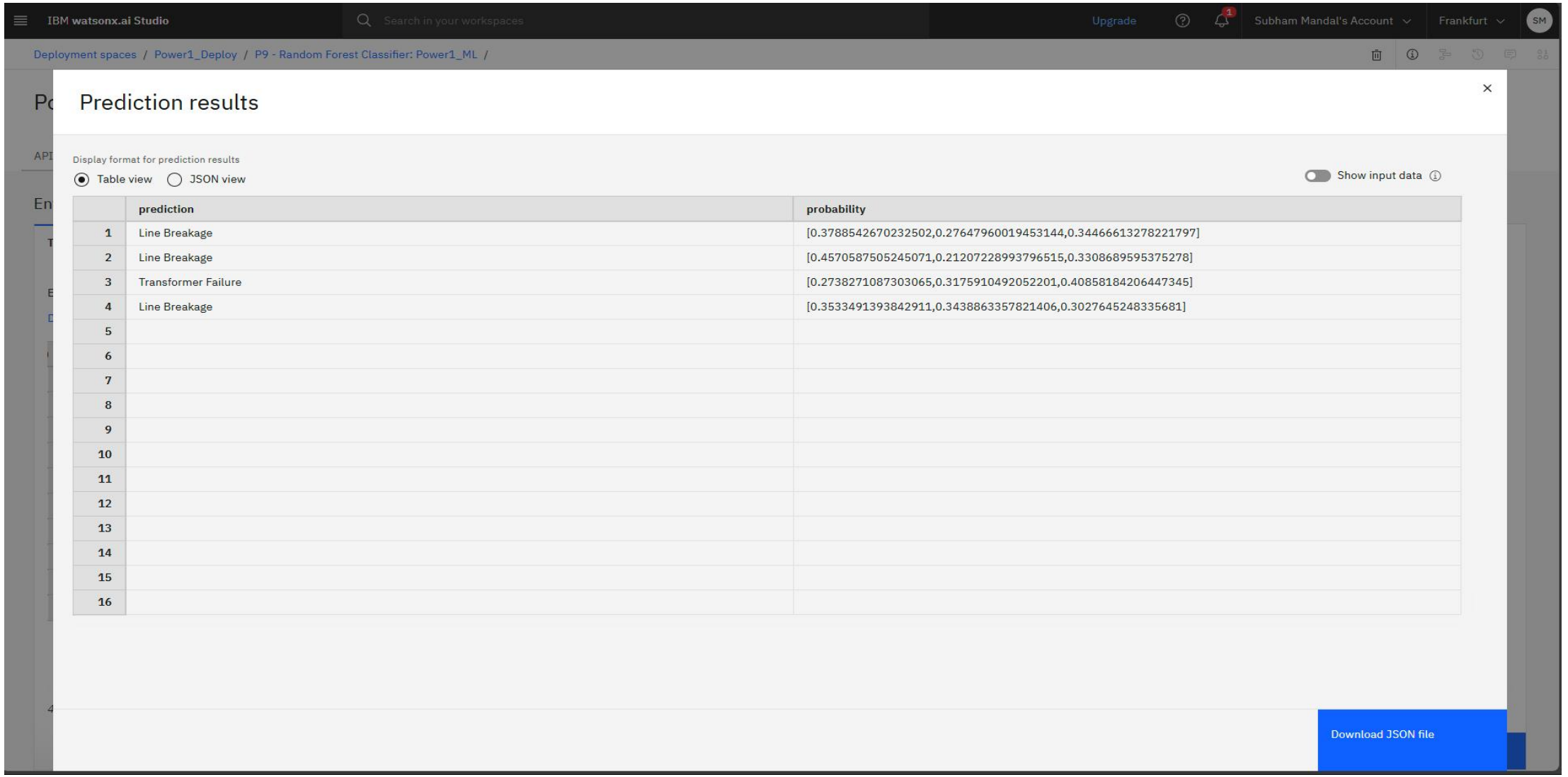
RESULT



	prediction	probability
1	Line Breakage	[0.3788542670232502,0.27647960019453144,0.34466613278221797]
2	Line Breakage	[0.4570587505245071,0.21207228993796515,0.3308689595375278]
3	Transformer Failure	[0.2738271087303065,0.3175910492052201,0.40858184206447345]
4	Line Breakage	[0.3533491393842911,0.3438863357821406,0.3027645248335681]
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CONCLUSION

- The developed machine learning model successfully classifies power system faults using supervised learning techniques with high accuracy, demonstrating strong potential for real-world application. Integration with IBM Cloud enhances the solution's scalability and ease of deployment. The experiment shows that cloud-based ML models can significantly reduce fault detection time. This improvement contributes to faster response, better maintenance planning, and overall grid reliability. The approach proves both technically feasible and practically impactful. Thus, the project validates the use of ML in modern power systems for enhanced fault management.

FUTURE SCOPE

- Integrate with real-time sensors (IoT)
- Extend to multi-region large-scale power systems
- Apply deep learning models (LSTM, CNN) for time-series based fault prediction
- Integrate with SCADA systems for industrial use
- Implement alert mechanisms using IBM Cloud functions

REFERENCES

- Power System Faults Dataset – Kaggle
- https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset
- Scikit-learn Documentation
- IBM Cloud Documentation
- IEEE Research Papers on Fault Detection

IBM CERTIFICATIONS

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In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution

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Subham Mandal

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 29, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/c32e0302-7319-4428-9d2a-9b6b2eb192b0

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IBM **SkillsBuild** Completion Certificate

This certificate is presented to

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According to the Adobe Learning Manager system of record

Completion date: 30 Jul 2025 (GMT) **Learning hours:** 20 mins

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