# 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

- **Data Acquisition & Understanding**
  Utilize the Kaggle dataset containing electrical parameters (Voltage, Current, etc.) under normal and various fault conditions.
- **Data Preprocessing**
  - Handle missing or inconsistent values
  - Normalize/standardize voltage & current readings
  - Encode fault types for classification
  - Perform feature selection to focus on key electrical signatures
- **Model Design**
  - Implement supervised machine learning algorithms (e.g., Random Forest, SVM, or Neural Networks)
  - Train models to classify:
    - Line-to-Ground Fault
    - Line-to-Line Fault
    - Three-Phase Fault
    - No Fault (Normal)
- **Cloud Integration – IBM Cloud Lite**
  - Use **IBM Watson Studio** for model development and training
  - Deploy trained model as a **REST API** using **IBM Cloud Functions** or **IBM Cloud Foundry**
  - Monitor performance and enable online predictions
- **Evaluation & Optimization**
  - Assess using accuracy, precision, recall, and F1-score
  - Use confusion matrix for detailed fault classification analysis
  - Fine-tune hyperparameters for optimal results
- **Outcome**
  A reliable ML system that can automatically detect and classify faults, enabling **faster fault response** and **power grid stability.**

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# SYSTEM APPROACH

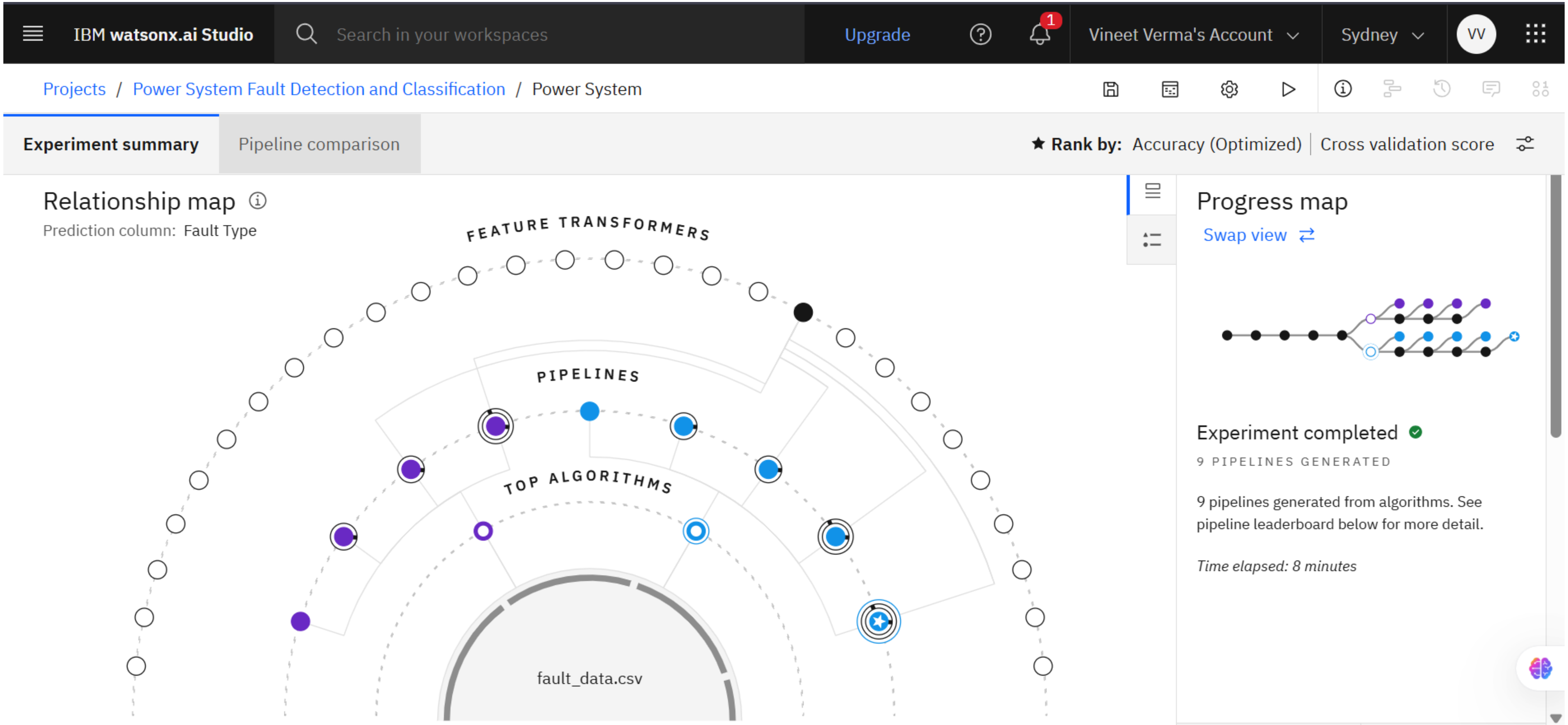
The "System Approach" section outlines the overall strategy and methodology for developing and implementing the Power System Fault Detection and Classification model. Here's a suggested structure for this section:

- System requirements – Windows 10 OS, 8GB RAM, Python 3.x
- Resources required on IBM Cloud platform to run AutoAI experiment – Watson Studio, Cloud Object Storage, Watson Machine Learning

# ALGORITHM & DEPLOYMENT

- Step 1 – Allocate Cloud Object Storage and Watson Studio in IBM Cloud
- Step 2 – Create a new project and enter project name, then click on create
- Step 3 – Associate Watson Machine Learning service
- Step 4 – Select AutoAI to automatically build models
- Step 5 – Enter a name and create the AutoAI experiment
- Step 6 – Upload the power system faults dataset from Kaggle to IBM Cloud and select it in AutoAI
- Step 7 – Select the target column (Fault Type) to classify fault types based on voltage and current readings
- Step 8 – Click on "Run Experiment“
- Step 9 – **Algorithm Selection:**
  AutoAI will automate model selection, hyperparameter tuning, and recommend the best classification model for power system faults
- Step 10 – Save the model with the highest accuracy
- Step 11 – Click "Promote to Deployment Space" to deploy the model
- Step 12 – Evaluation and testing using new voltage/current data for fault prediction

# RESULT


IBM watsonx.ai Studio
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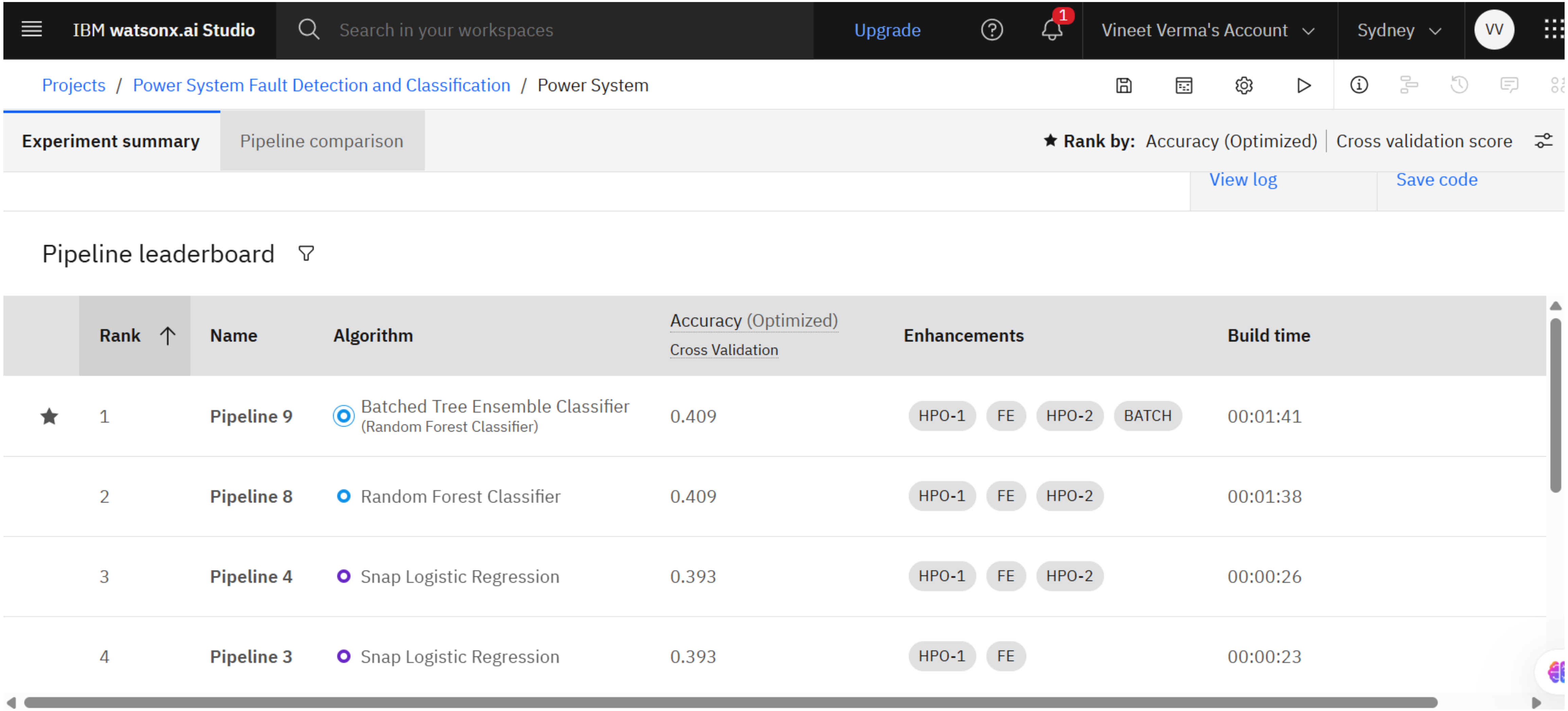
Upgrade
Vineet Verma's Account
Sydney
VV
Projects / Power System Fault Detection and Classification / Power System
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
fault_data.csv
Progress map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 8 minutes



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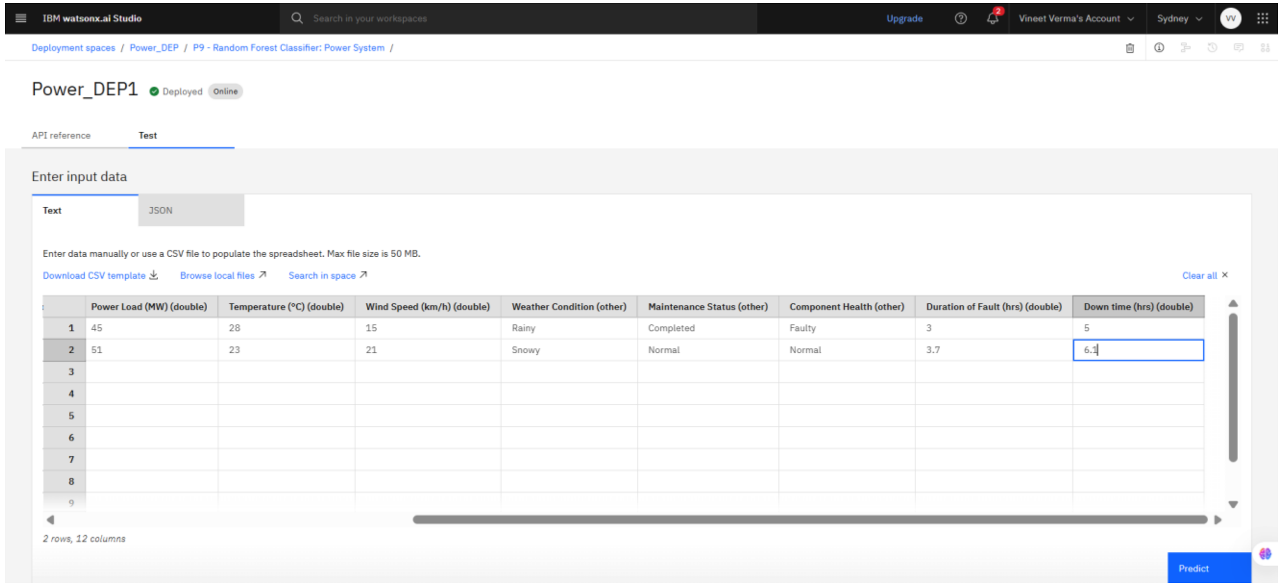
VV
Projects / Power System Fault Detection and Classification / Power System
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Accuracy (Optimized)
Cross Validation
Enhancements
Build time
1 Pipeline 9 Batched Tree Ensemble Classifier (Random Forest Classifier) 0.409 HPO-1 FE HPO-2 BATCH 00:01:41
2 Pipeline 8 Random Forest Classifier 0.409 HPO-1 FE HPO-2 00:01:38
3 Pipeline 4 Snap Logistic Regression 0.393 HPO-1 FE HPO-2 00:00:26
4 Pipeline 3 Snap Logistic Regression 0.393 HPO-1 FE 00:00:23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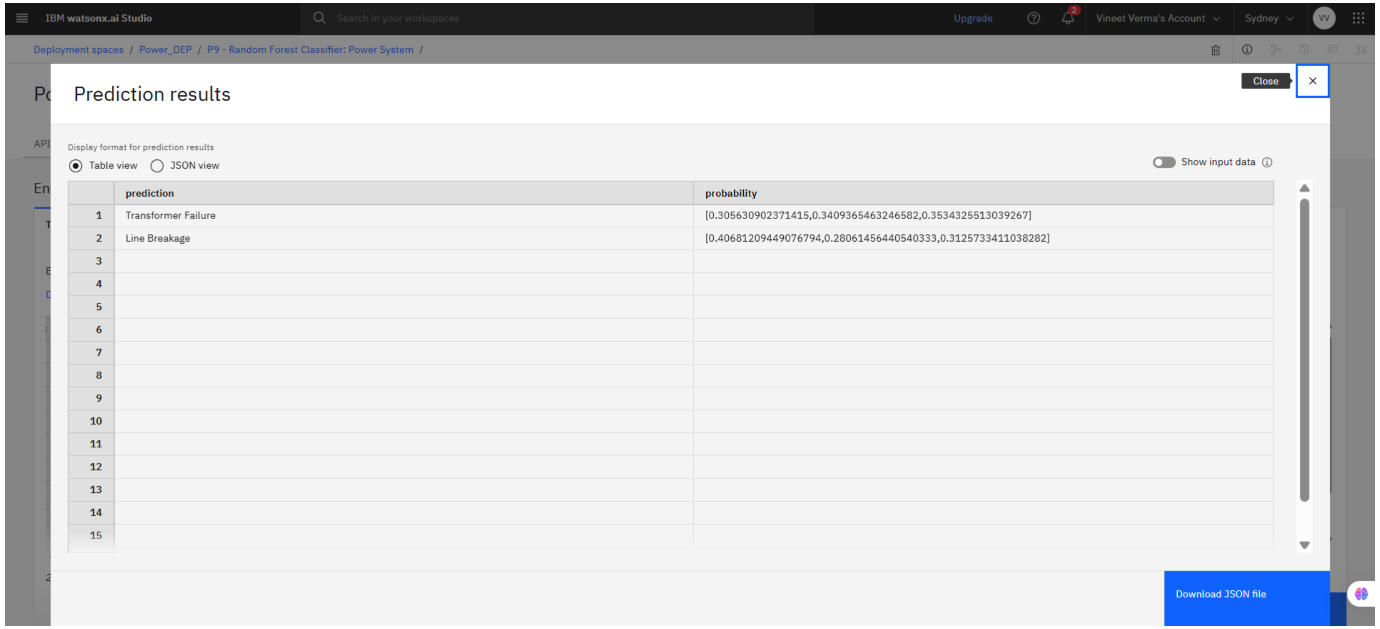
Deployment spaces / Power_DEP / P9 - Random Forest Classifier: Power System /
Power_DEP1
Deployed
Online
API reference
Test
Enter input data
Text
JSON
Enter data manually or use a CSV file to populate the spreadsheet. Max file size is 50 MB.
Download CSV template
Browse local files
Search in space
Clear 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 45 28 15 Rainy Completed Faulty 3 5
2 51 23 21 Snowy Normal Normal 3.7 6.1
2 rows, 12 columns
Predict


IBM watsonx.ai Studio
Search in your workspaces
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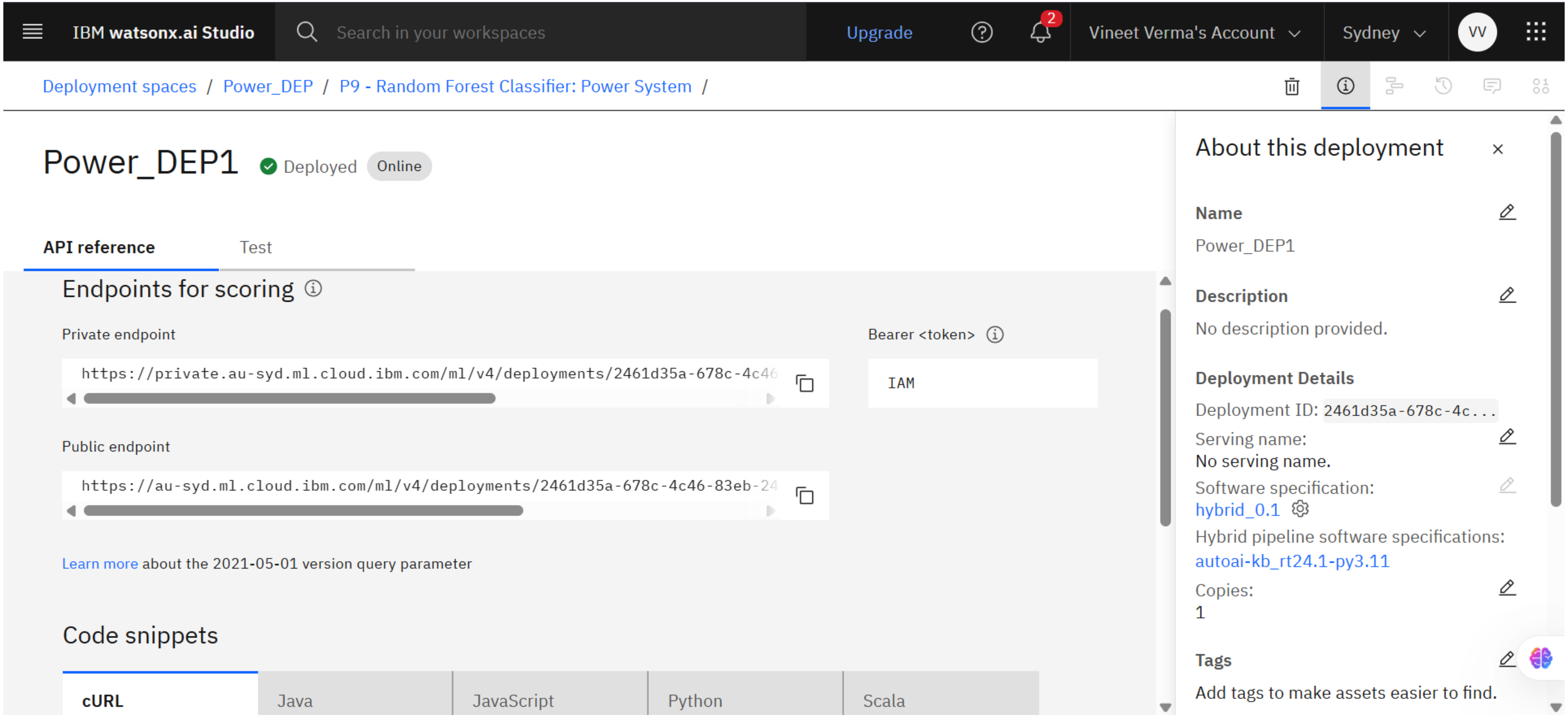
Sydney
Deployment spaces / Power_DEP / P9 - Random Forest Classifier: Power System /
Prediction results
Close
Display format for prediction results
Table view
JSON view
Show input data
prediction
probability
1 Transformer Failure [0.305630902371415,0.3409365463246582,0.3534325513039267]
2 Line Breakage [0.40681209449076794,0.28061456440540333,0.3125733411038282]
Download JSON file

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# CONCLUSION

- The system successfully detects and classifies different types of power system faults using machine learning techniques, ensuring rapid and accurate fault identification.
- This approach enables electrical utilities to respond faster to faults, reduce downtime, and maintain grid stability and reliability.
- The results highlight the significance of integrating machine learning into power systems for real-time monitoring and intelligent fault management. By leveraging such data-driven solutions, power distribution networks can become more efficient, resilient, and future-ready.

# FUTURE SCOPE

- **Real-Time Integration:** Connect with SCADA/smart meters for live fault detection.
- **Fault Location Estimation:** Extend model to pinpoint fault locations on the grid.
- **Edge Deployment:** Deploy lightweight models on substations for on-site analysis.
- **Renewable Support:** Adapt system for dynamic behavior from solar and wind sources.
- **Scalability:** Scale to large power grids using cloud-native and distributed systems.
- **Automated Alerts:** Use IBM Cloud to trigger real-time alerts and maintenance actions.

# REFERENCES

- ChatGPT
- IBM cloud platform
- **Research Paper** – *"Power System Fault Detection and Classification Using Machine Learning"* – Link to paper
- Project Link –

https://dataplatform.cloud.ibm.com/projects/846904b4-ea60-4dee-b506-01ca07e1daa7?context=cpdaas

# IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

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IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Vineet Verma

for the completion of

**Lab: Retrieval Augmented Generation with LangChain**

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 25 Jul 2025 (GMT)

**Learning hours:** 20 mins

# THANK YOU