CAPSTONE PROJECT

Power System Fault Detection and Classification

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OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- 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

- We propose a machine learning–based solution that classifies different power system faults using historical electrical measurement data.
- The model uses supervised learning techniques to identify patterns in the voltage and current phasors.
- The solution is developed using IBM Watson Studio on IBM Cloud, where we train and test the model, while IBM Cloud Object Storage is used to store and manage the dataset.
- The trained model can classify faults in real-time, helping utility companies to act quickly and restore normal conditions efficiently.

SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the rental bike prediction system. Here's a suggested structure for this section:

- **System requirements**

  IBM Cloud account (Lite plan – Free tier)

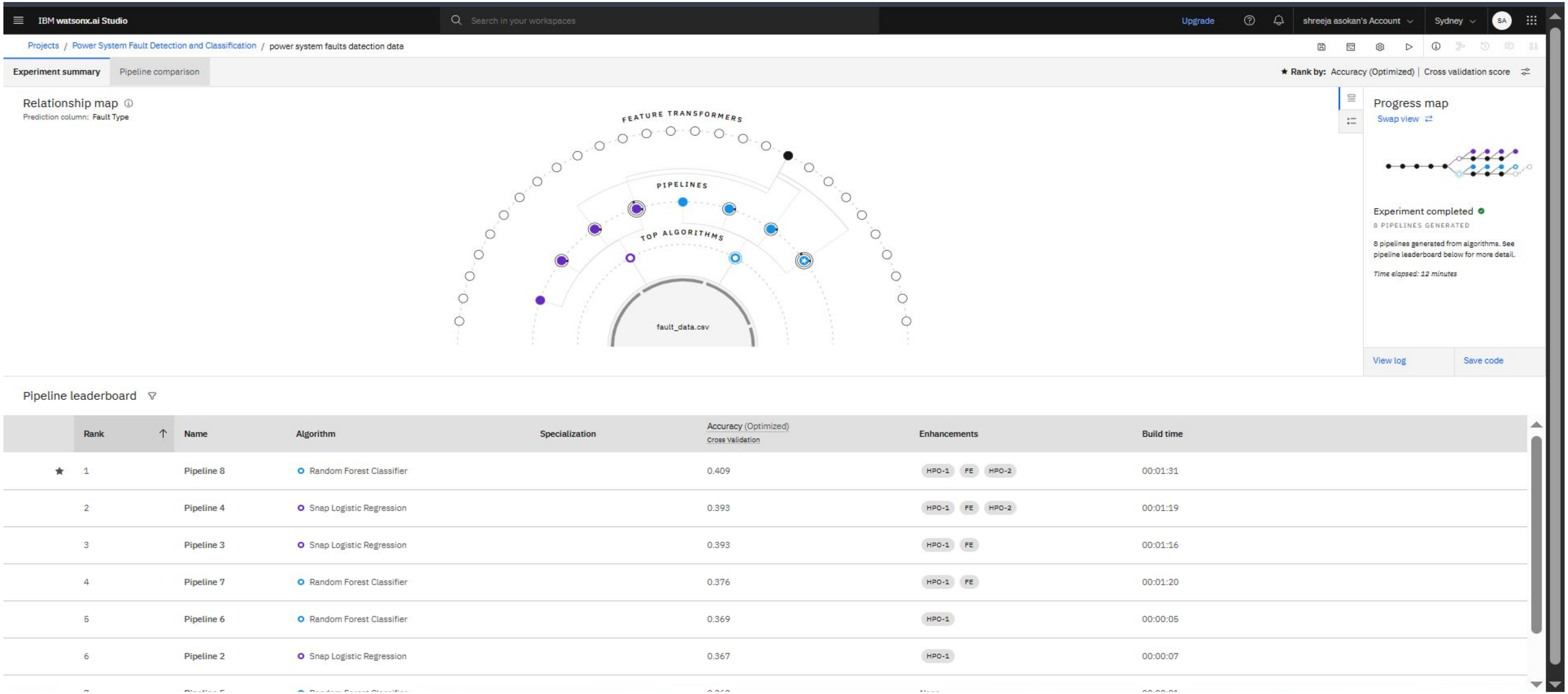
  IBM Watson Studio (Notebook environment)

  IBM Cloud Object Storage (to store data)

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  - We used the **Random Forest Classifier**, a supervised learning algorithm known for its accuracy and reliability. It is suitable for classification problems and works well with tabular data. The algorithm was chosen because it can handle multiple fault types and provides good results with limited feature tuning.
- **Data Input:**
  - The input data includes electrical measurements such as **voltage and current phasors** from all three phases. These features help the model detect patterns in the signal that correspond to different types of power faults, including.
- **Training Process:**
  - The dataset was split into **80% training** and **20% testing** data. We used `scikit-learn` to train the Random Forest model. The training was performed in **IBM Watson Studio** using a Python notebook. No advanced tuning was required, but cross-validation can be added to improve the model.
- **Prediction Process:**
  - After training, the model can take new voltage and current values as input and **predict the fault type** in real time. These predictions can help operators quickly respond to system issues. The model can also be exported and deployed using **IBM Watson Machine Learning** as a REST API to integrate with real systems.

RESULT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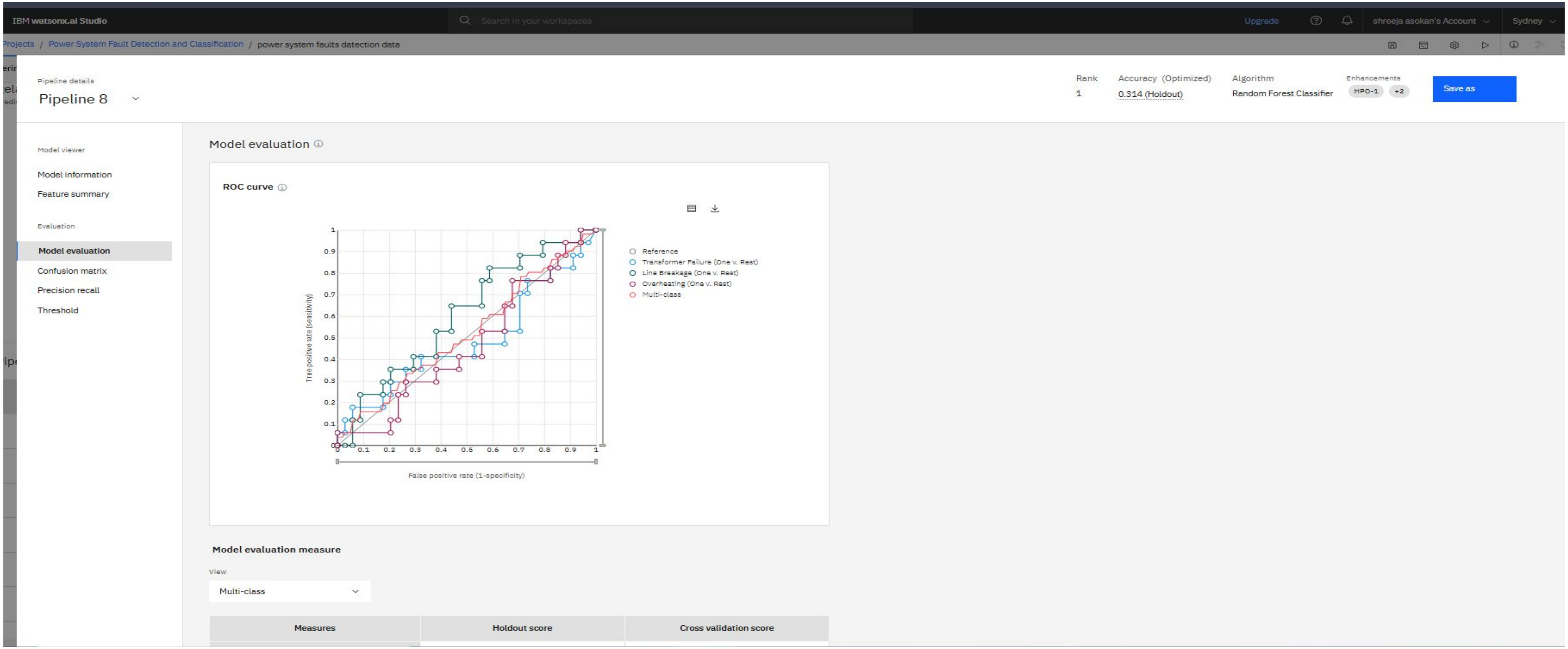
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized) | Cross validation score
Relationship map
Prediction column: Fault Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
fault_data.csv
Progress map
Swap view
Experiment completed
8 PIPELINES GENERATED
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 12 minutes
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Cross Validation
Enhancements
Build time
1 Pipeline 8 Random Forest Classifier 0.409 HPO-1 FE HPO-2 00:01:31
2 Pipeline 4 Snap Logistic Regression 0.393 HPO-1 FE HPO-2 00:01:19
3 Pipeline 3 Snap Logistic Regression 0.393 HPO-1 FE 00:01:16
4 Pipeline 7 Random Forest Classifier 0.376 HPO-1 FE 00:01:20
5 Pipeline 6 Random Forest Classifier 0.369 HPO-1 00:00:05
6 Pipeline 2 Snap Logistic Regression 0.367 HPO-1 00:00:07

RESULT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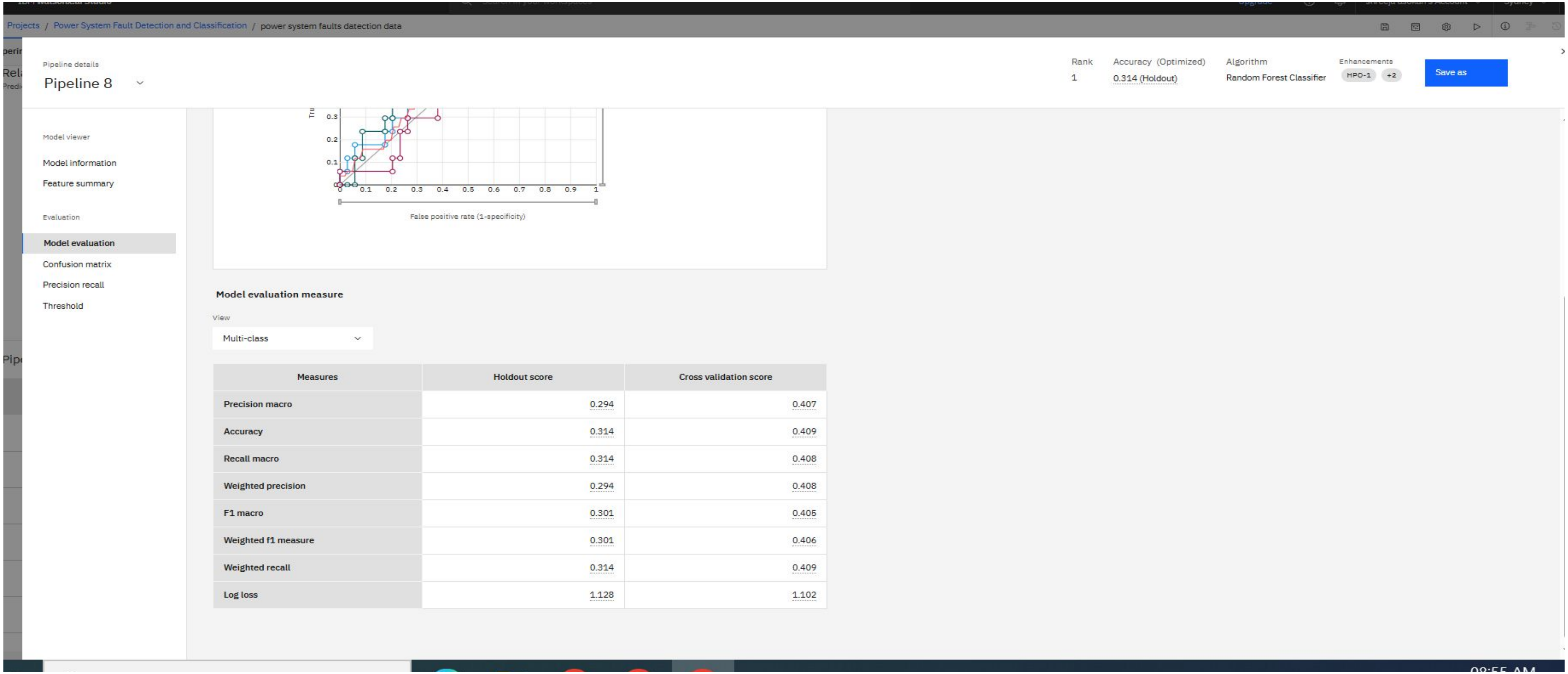
Pipeline details
Pipeline 8
Rank
1
Accuracy (Optimized)
0.314 (Holdout)
Algorithm
Random Forest Classifier
Enhancements
HPO-1
+2
Save as
Model viewer
Model information
Feature summary
Evaluation
Model evaluation
Confusion matrix
Precision recall
Threshold
Model evaluation
ROC curve
True positive rate (sensitivity)
False positive rate (1-specificity)
Reference
Transformer Failure (One v. Rest)
Line Breakage (One v. Rest)
Overheating (One v. Rest)
Multi-class
Model evaluation measure
View
Multi-class
Measures
Holdout score
Cross validation score

RESULT



Measures	Holdout score	Cross validation score
Precision macro	0.294	0.407
Accuracy	0.314	0.409
Recall macro	0.314	0.408
Weighted precision	0.294	0.408
F1 macro	0.301	0.405
Weighted f1 measure	0.301	0.406
Weighted recall	0.314	0.409
Log loss	1.128	1.102

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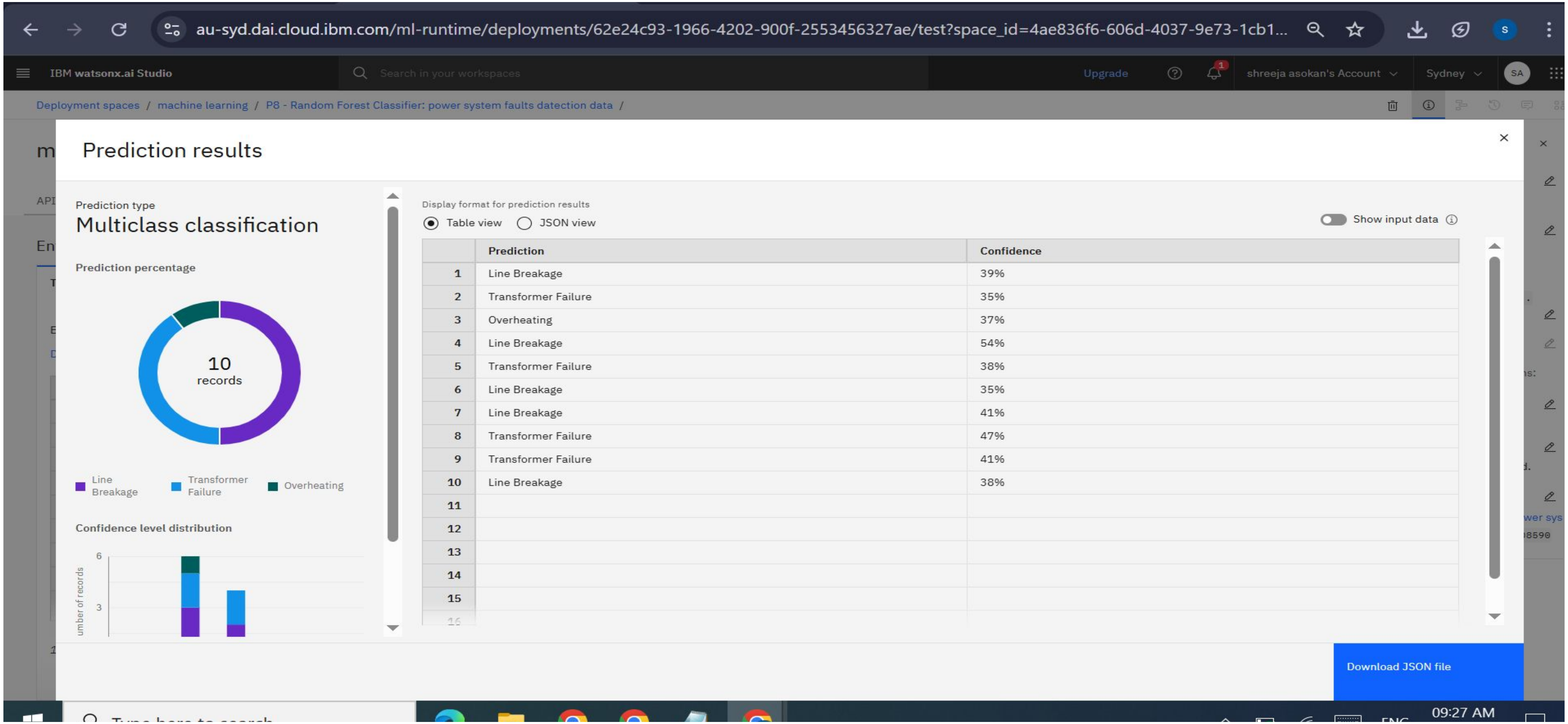
RESULT



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Deployment spaces / machine learning / P8 - Random Forest Classifier: power system faults datection data /
Prediction results
Prediction type
Multiclass classification
Prediction percentage
10 records
Line Breakage
Transformer Failure
Overheating
Confidence level distribution
umber of records
6
3
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 Line Breakage 39%
2 Transformer Failure 35%
3 Overheating 37%
4 Line Breakage 54%
5 Transformer Failure 38%
6 Line Breakage 35%
7 Line Breakage 41%
8 Transformer Failure 47%
9 Transformer Failure 41%
10 Line Breakage 38%
11
12
13
14
15
Download JSON file
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