CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

Presented By:
1. KODALI PAVANI - Koneru Lakshmaiah University

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

Develop a robust machine learning model capable of accurately detecting and classifying various types of faults in a power distribution system using electrical measurement data. The model should rapidly distinguish between normal and fault conditions (e.g., line-to-ground, line-to-line, or three-phase faults), enabling faster recovery actions and enhancing system reliability.

1. Data Collection:Source a relevant dataset on power system faults from Kaggle or a similar platform containing electrical parameters like voltage and current phasors.
2. 2. Data Preprocessing:Perform data cleaning and normalization to ensure the dataset is free from noise, inconsistencies, and missing values. This step is critical for improving model accuracy.
3. 3. Model Development:Implement and train a supervised classification model such as Decision Tree, Random Forest, or Support Vector Machine (SVM) to identify fault types based on the input features.
4. 4. Model Evaluation:Assess the performance of the trained model using standard metrics including accuracy, precision, recall, and F1-score. This will help ensure the reliability and effectiveness of the fault detection system.

SYSTEM APPROACH

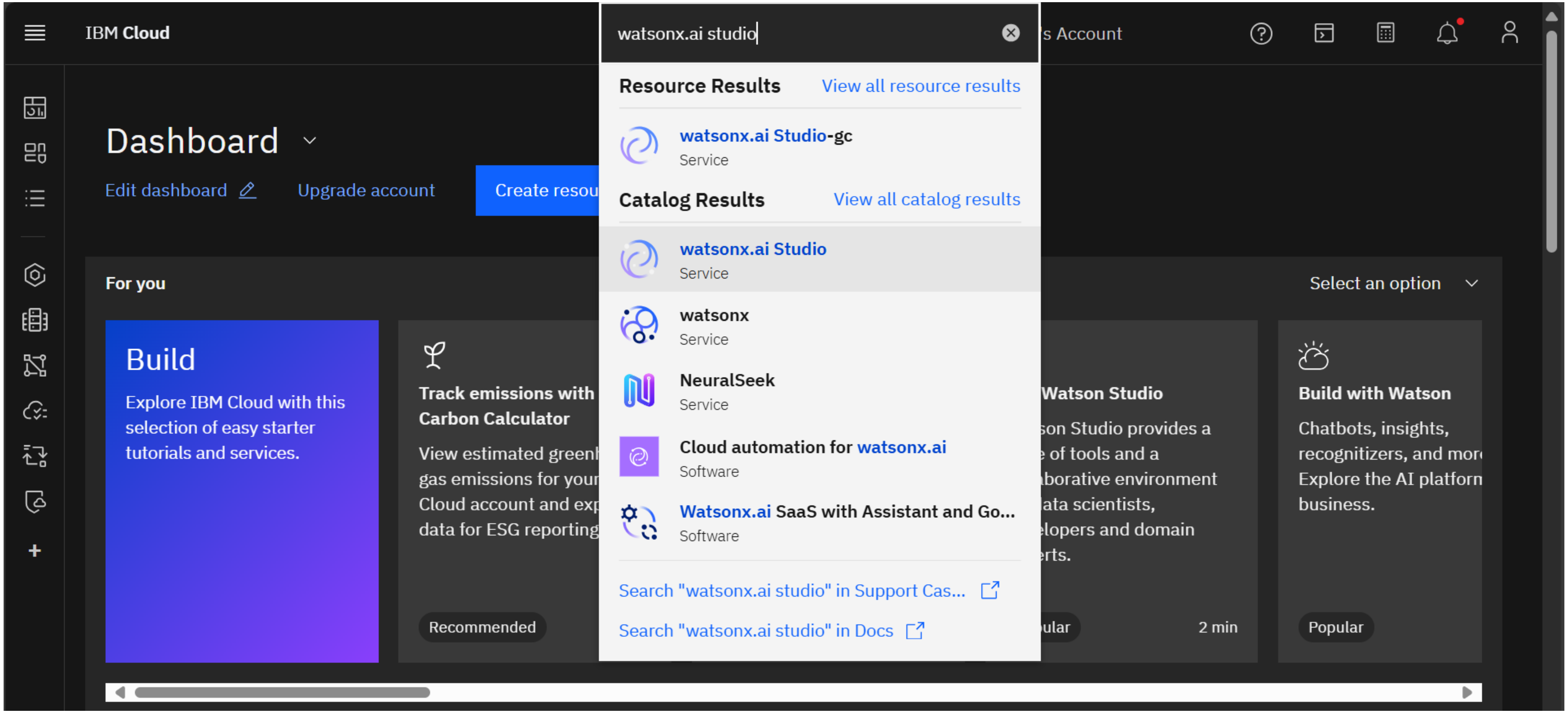
The "System Approach" section describes the overall strategy and methodology used to design, develop, and implement the power system fault detection and classification model. Below is a suggested framework for outlining this section:

•**IBM Cloud (Mandatory):**
Serves as the primary cloud platform for the entire project infrastructure, including computing, storage, and deployment services.
•**IBM Watson Studio:**
Utilized for building, training, and deploying the machine learning model. It provides an integrated environment for data scientists and developers to work efficiently.
•**IBM Cloud Object Storage:**
Used for securely storing and managing the dataset. It enables seamless access to data for preprocessing and training workflows.

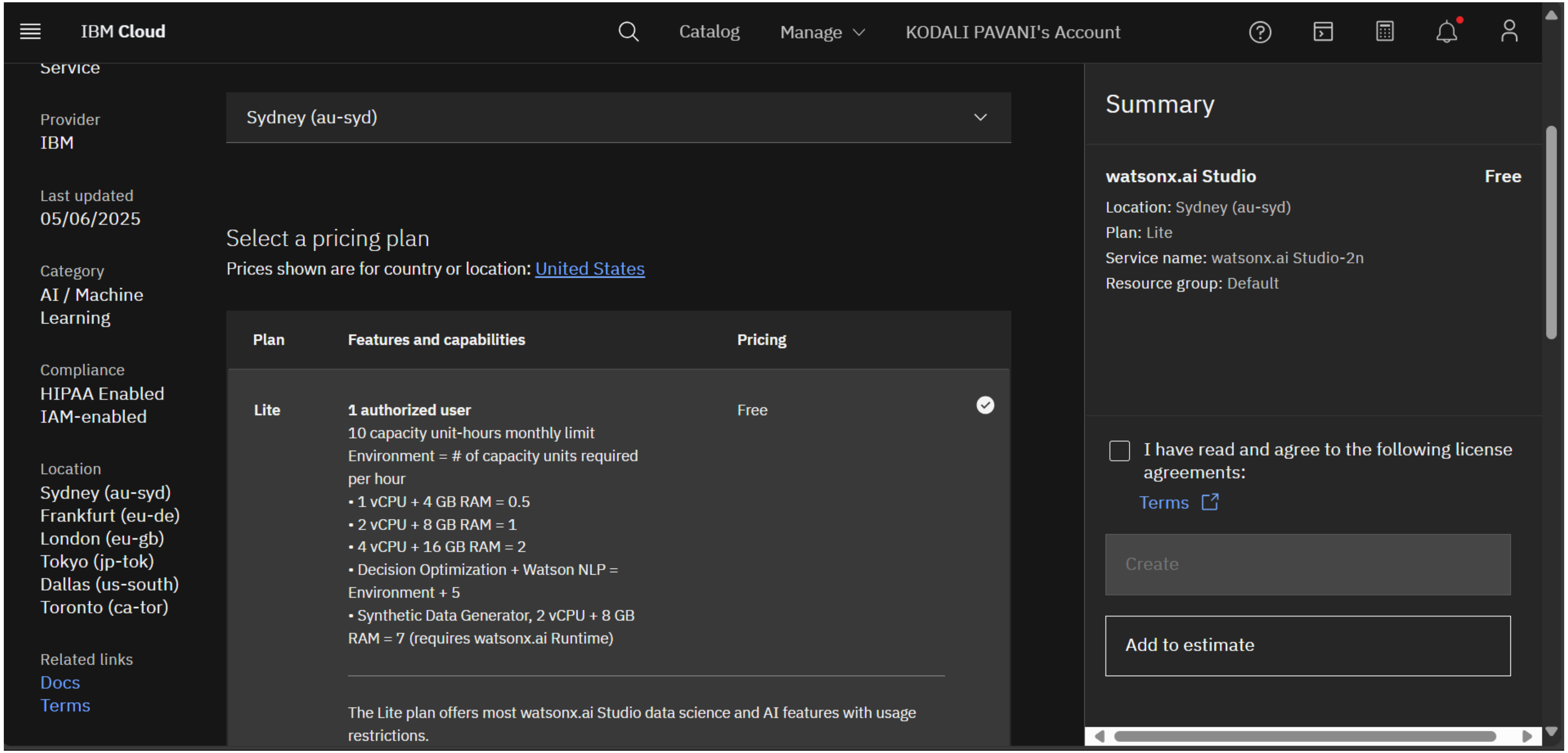
ALGORITHM & DEPLOYMENT

•**Data Collection**
Gather voltage and current phasor data from a Kaggle dataset.
•**Data Preprocessing**
Clean, normalize, and split the data into training and testing sets.
•**Feature Engineering**
Extract meaningful features (e.g., magnitude, phase angle) for classification.
•**Model Selection**
Choose and configure ML models (e.g., Random Forest, SVM, or Neural Network).
•**Model Training**
Train the model using labeled data on IBM Cloud Watson Studio.
•**Model Evaluation**
Test the model and evaluate accuracy, precision, recall, and F1-score.
•**Fault Classification**
Classify conditions as normal, LG, LL, or 3-phase fault.
•**Deployment**
Deploy the model using IBM Cloud (Lite) services for real-time prediction.
•**Visualization & Reporting**
Display fault types and detection accuracy through charts and dashboards.

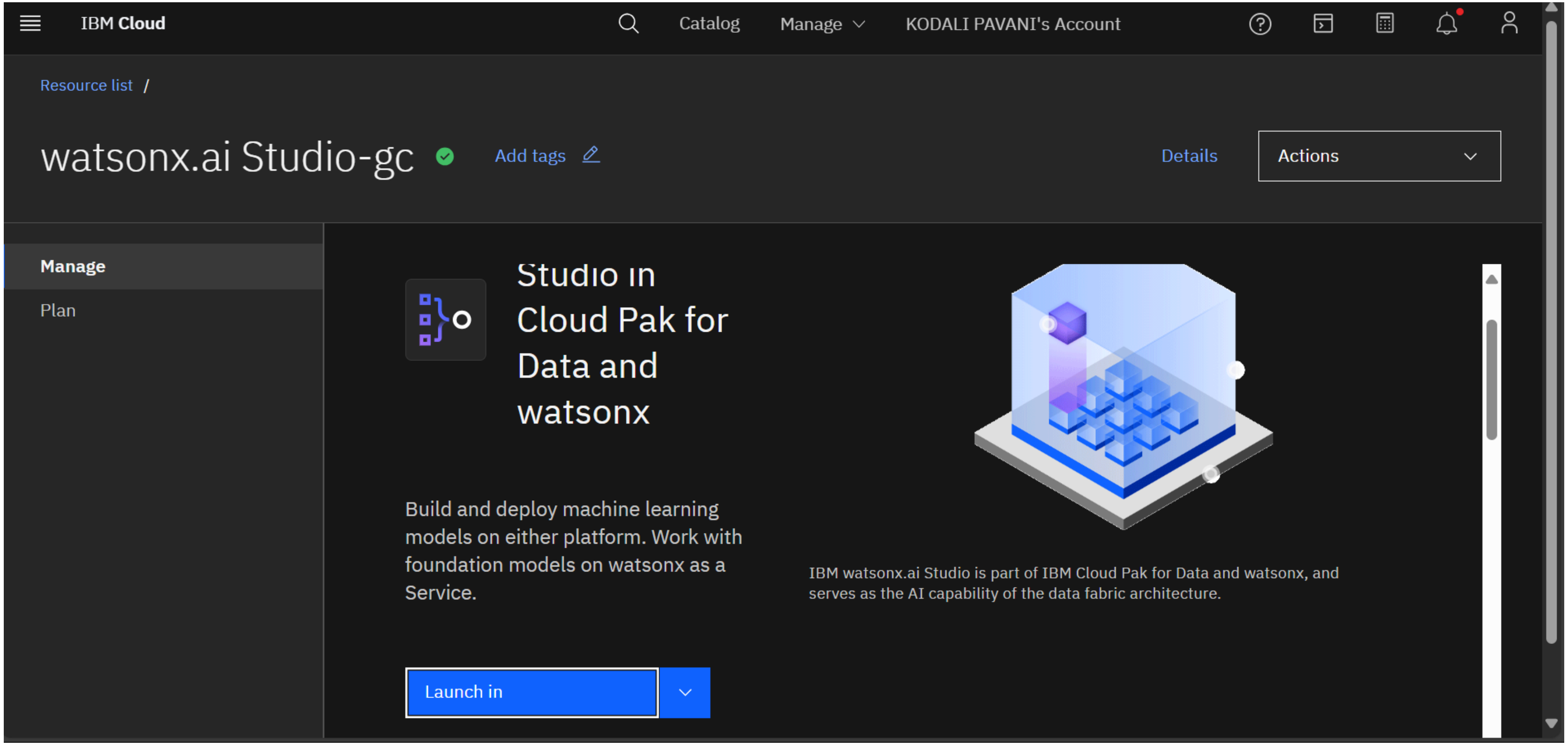
RESULT


IBM Cloud
watsonx.ai studio
s Account
Resource Results
View all resource results
watsonx.ai Studio-gc
Service
Catalog Results
View all catalog results
watsonx.ai Studio
Service
watsonx
Service
NeuralSeek
Service
Cloud automation for watsonx.ai
Software
Watsonx.ai SaaS with Assistant and Go...
Software
Search "watsonx.ai studio" in Support Cas...
Search "watsonx.ai studio" in Docs
Dashboard
Edit dashboard
Upgrade account
Create resou
For you
Select an option
Build
Explore IBM Cloud with this selection of easy starter tutorials and services.
Track emissions with Carbon Calculator
View estimated greenh gas emissions for your Cloud account and exp data for ESG reporting
Recommended
Watson Studio
son Studio provides a e of tools and a borative environment ata scientists, elopers and domain erts.
ular
2 min
Build with Watson
Chatbots, insights, recognitizers, and more Explore the AI platform business.
Popular

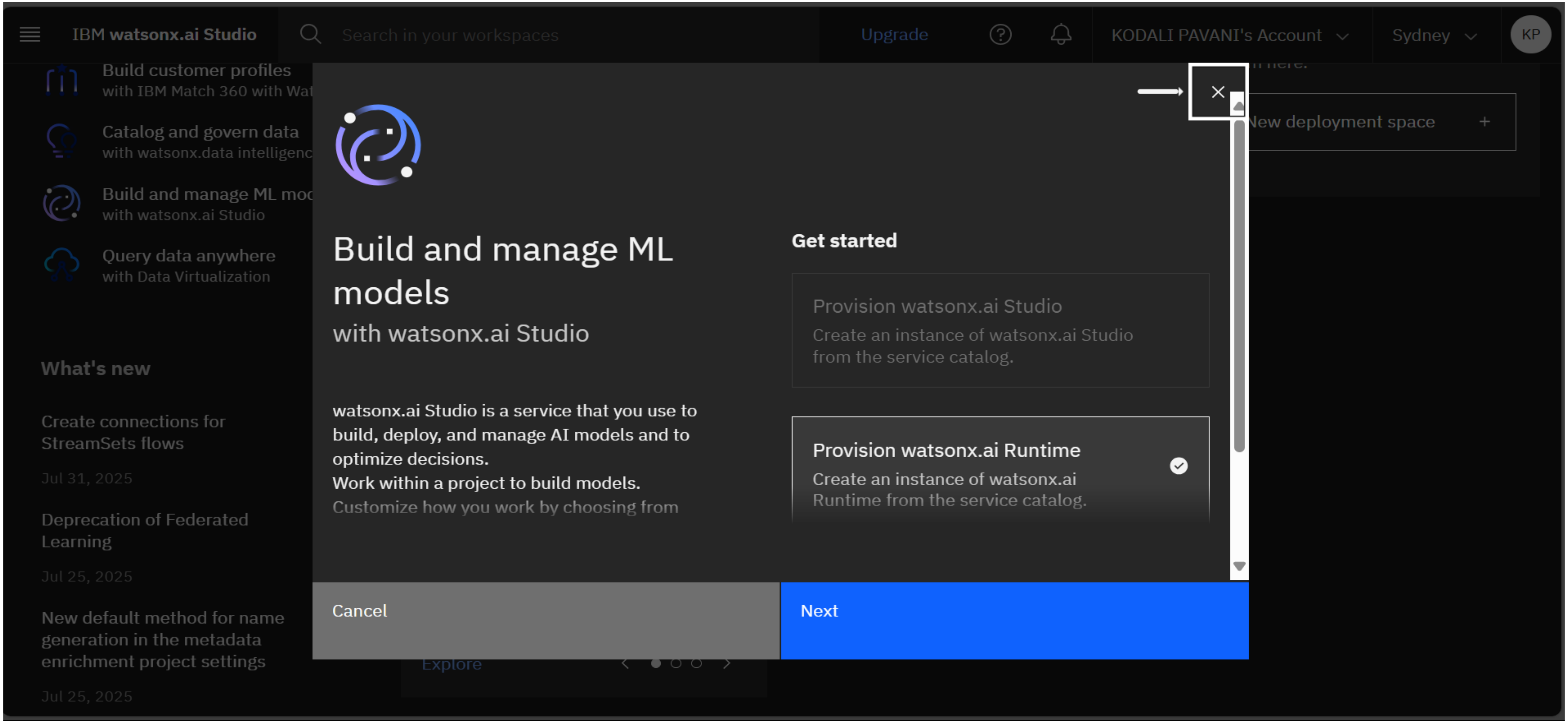
RESULT


IBM Cloud
Catalog
Manage
KODALI PAVANI's Account
Service
Provider
IBM
Last updated
05/06/2025
Category
AI / Machine Learning
Compliance
HIPAA Enabled
IAM-enabled
Location
Sydney (au-syd)
Frankfurt (eu-de)
London (eu-gb)
Tokyo (jp-tok)
Dallas (us-south)
Toronto (ca-tor)
Related links
Docs
Terms
Sydney (au-syd)
Select a pricing plan
Prices shown are for country or location: United States
Plan
Features and capabilities
Pricing
Lite
1 authorized user
10 capacity unit-hours monthly limit
Environment = # of capacity units required per hour
• 1 vCPU + 4 GB RAM = 0.5
• 2 vCPU + 8 GB RAM = 1
• 4 vCPU + 16 GB RAM = 2
• Decision Optimization + Watson NLP = Environment + 5
• Synthetic Data Generator, 2 vCPU + 8 GB RAM = 7 (requires watsonx.ai Runtime)
Free
The Lite plan offers most watsonx.ai Studio data science and AI features with usage restrictions.
Summary
watsonx.ai Studio
Free
Location: Sydney (au-syd)
Plan: Lite
Service name: watsonx.ai Studio-2n
Resource group: Default
I have read and agree to the following license agreements:
Terms
Create
Add to estimate

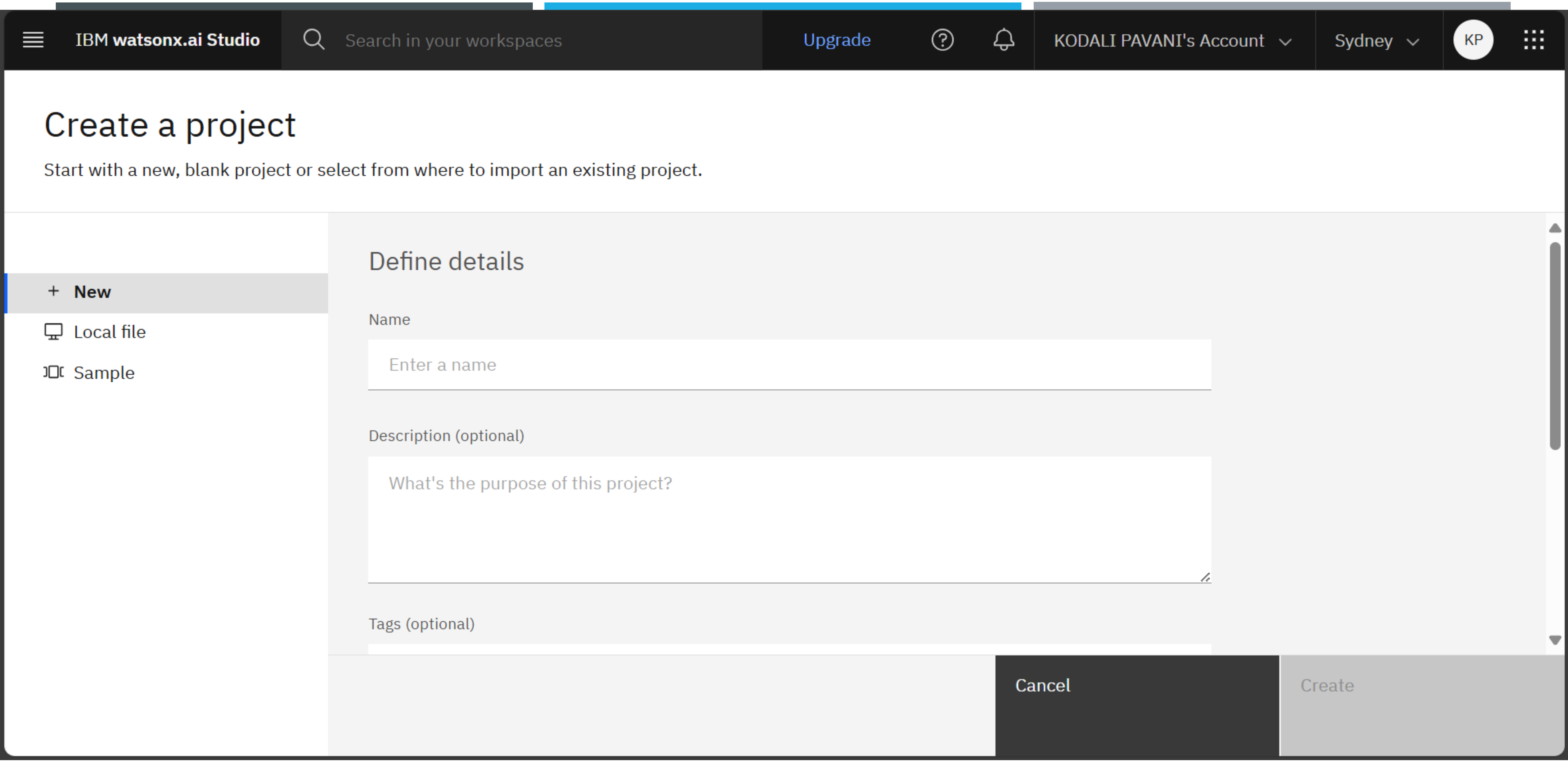
RESULT


IBM Cloud
Catalog
Manage
KODALI PAVANI's Account
Resource list /
watsonx.ai Studio-gc
Add tags
Details
Actions
Manage
Plan
Studio in Cloud Pak for Data and watsonx
Build and deploy machine learning models on either platform. Work with foundation models on watsonx as a Service.
IBM watsonx.ai Studio is part of IBM Cloud Pak for Data and watsonx, and serves as the AI capability of the data fabric architecture.
Launch in

RESULT

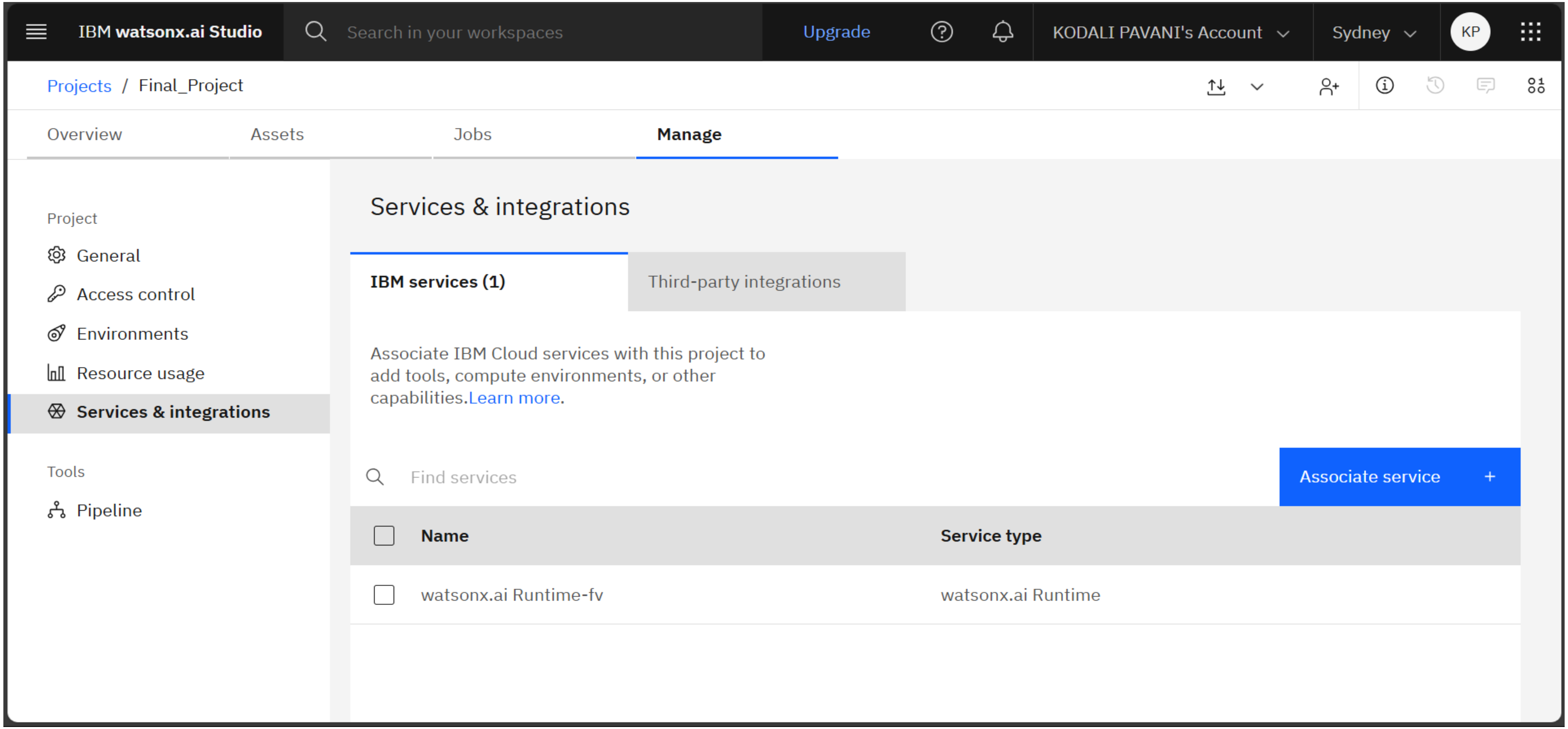


IBM watsonx.ai Studio
Search in your workspaces
Upgrade
KODALI PAVANI's Account
Sydney
KP
Build customer profiles
Catalog and govern data
Build and manage ML models
with watsonx.ai Studio
Query data anywhere
with Data Virtualization
What's new
Create connections for StreamSets flows
Jul 31, 2025
Deprecation of Federated Learning
Jul 25, 2025
New default method for name generation in the metadata enrichment project settings
Jul 25, 2025
New deployment space
Build and manage ML models
with watsonx.ai Studio
watsonx.ai Studio is a service that you use to build, deploy, and manage AI models and to optimize decisions.
Work within a project to build models.
Customize how you work by choosing from
Get started
Provision watsonx.ai Studio
Create an instance of watsonx.ai Studio from the service catalog.
Provision watsonx.ai Runtime
Create an instance of watsonx.ai Runtime from the service catalog.
Cancel
Next
Explore



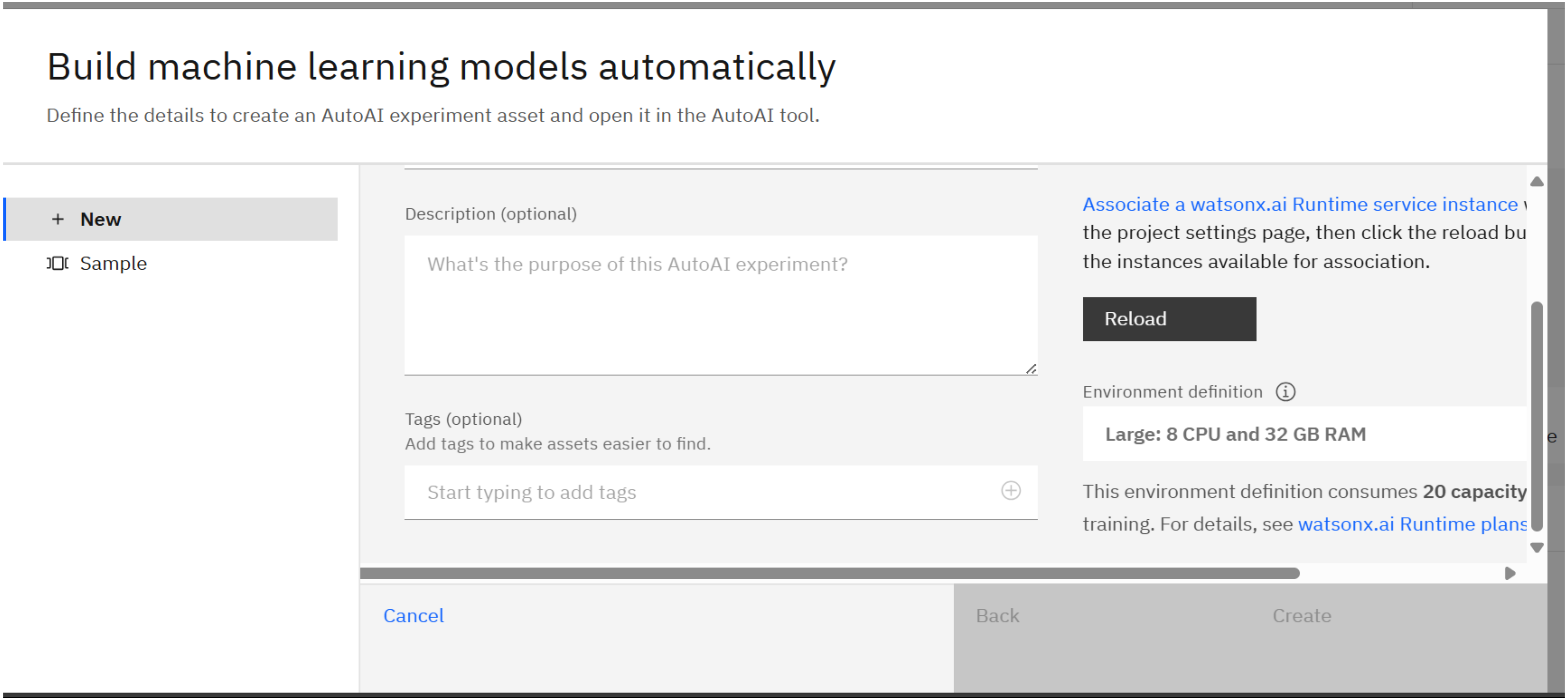
edunet
foundation

RESULT



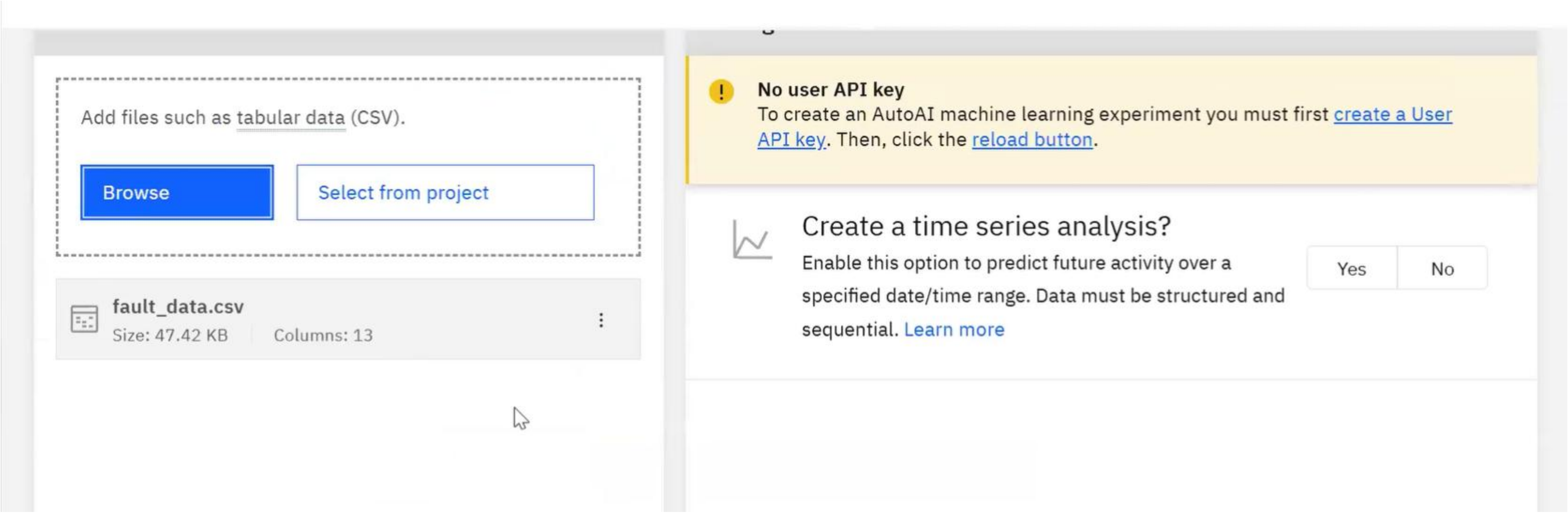
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
KODALI PAVANI's Account
Sydney
KP
Projects / Final_Project
Overview
Assets
Jobs
Manage
Project
General
Access control
Environments
Resource usage
Services & integrations
Tools
Pipeline
Services & integrations
IBM services (1)
Third-party integrations
Associate IBM Cloud services with this project to add tools, compute environments, or other capabilities.Learn more.
Find services
Associate service +
Name
Service type
watsonx.ai Runtime-fv
watsonx.ai Runtime

RESULT



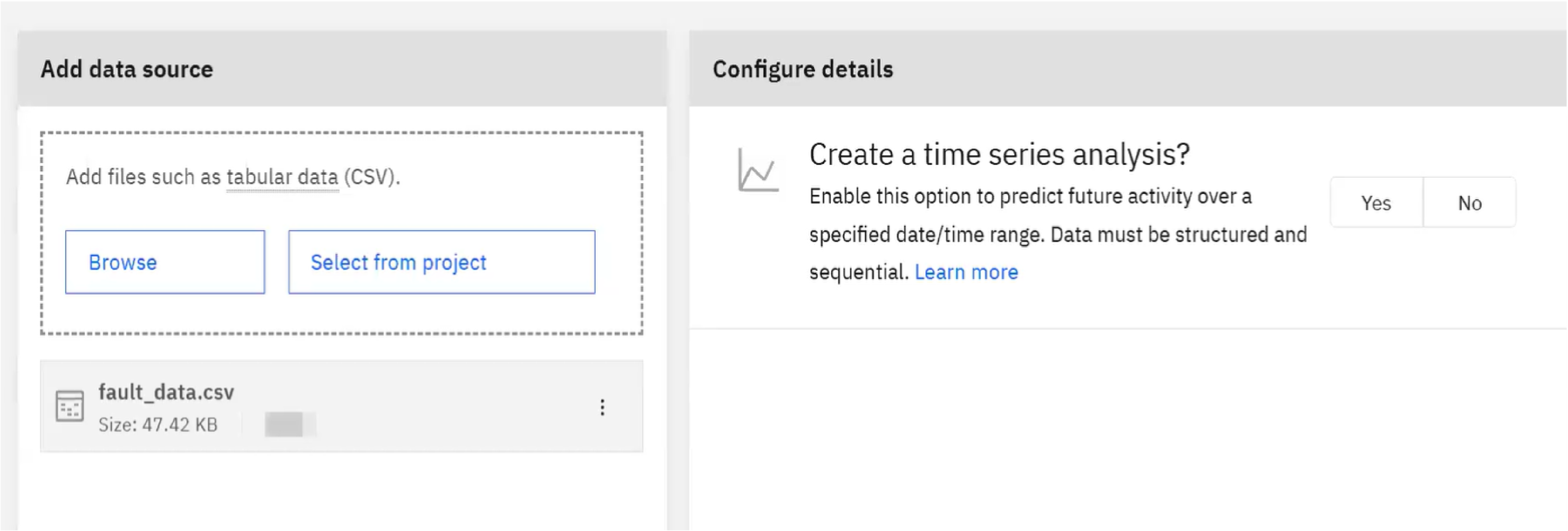
Build machine learning models automatically
Define the details to create an AutoAI experiment asset and open it in the AutoAI tool.
+ New
Sample
Description (optional)
What's the purpose of this AutoAI experiment?
Tags (optional)
Add tags to make assets easier to find.
Start typing to add tags
Associate a watsonx.ai Runtime service instance
the project settings page, then click the reload bu
the instances available for association.
Reload
Environment definition
Large: 8 CPU and 32 GB RAM
This environment definition consumes 20 capacity
training. For details, see watsonx.ai Runtime plans
Cancel
Back
Create

RESULT

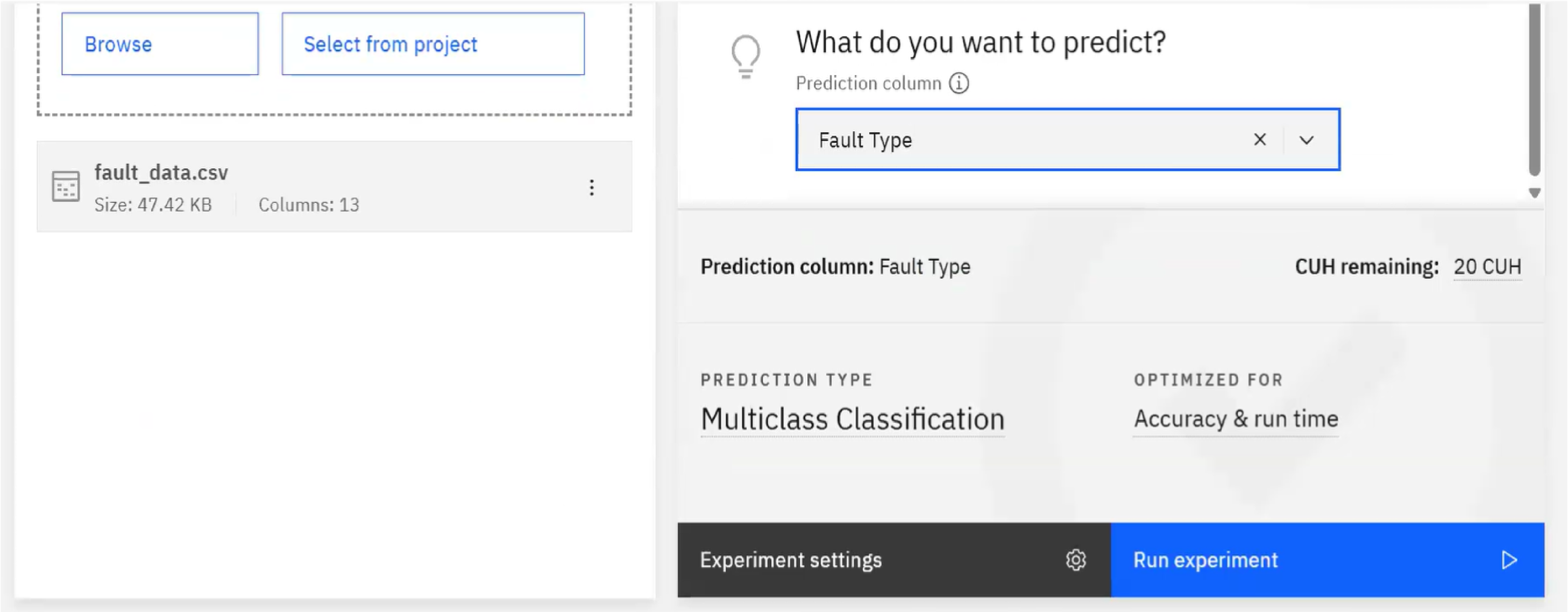


edunet foundation

RESULT

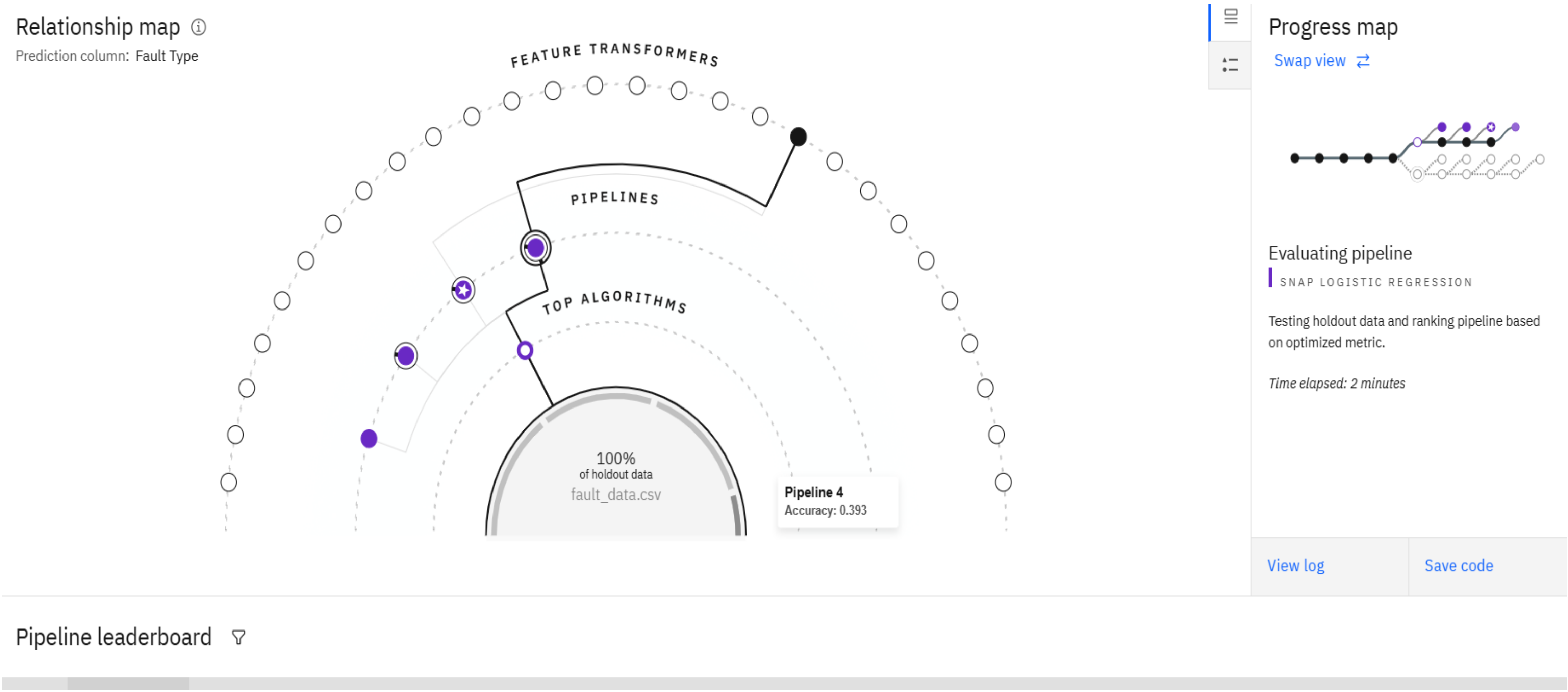

Add data source
Add files such as tabular data (CSV).
Browse
Select from project
fault_data.csv
Size: 47.42 KB
Configure details
Create a time series analysis?
Enable this option to predict future activity over a specified date/time range. Data must be structured and sequential. Learn more
Yes
No

RESULT



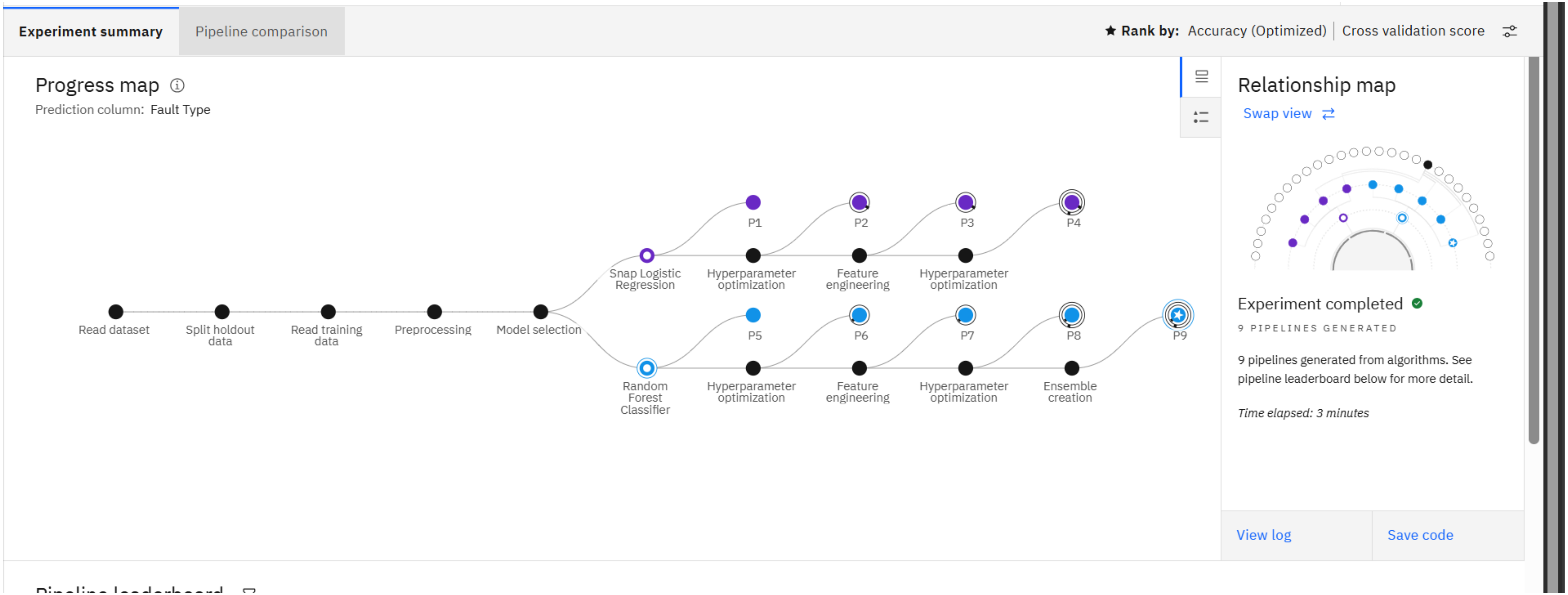
edunet foundation

RESULT



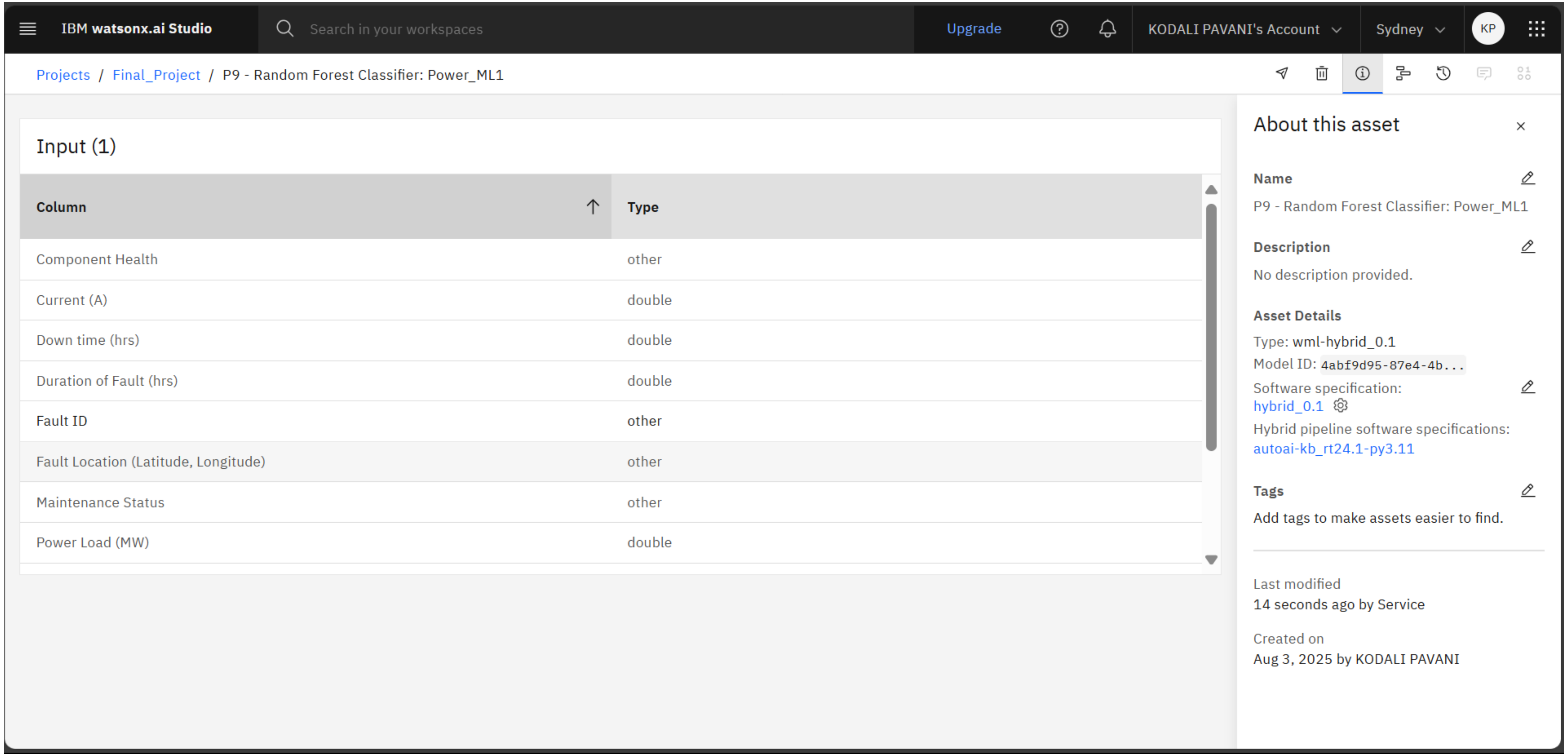
edunet
foundation

RESULT



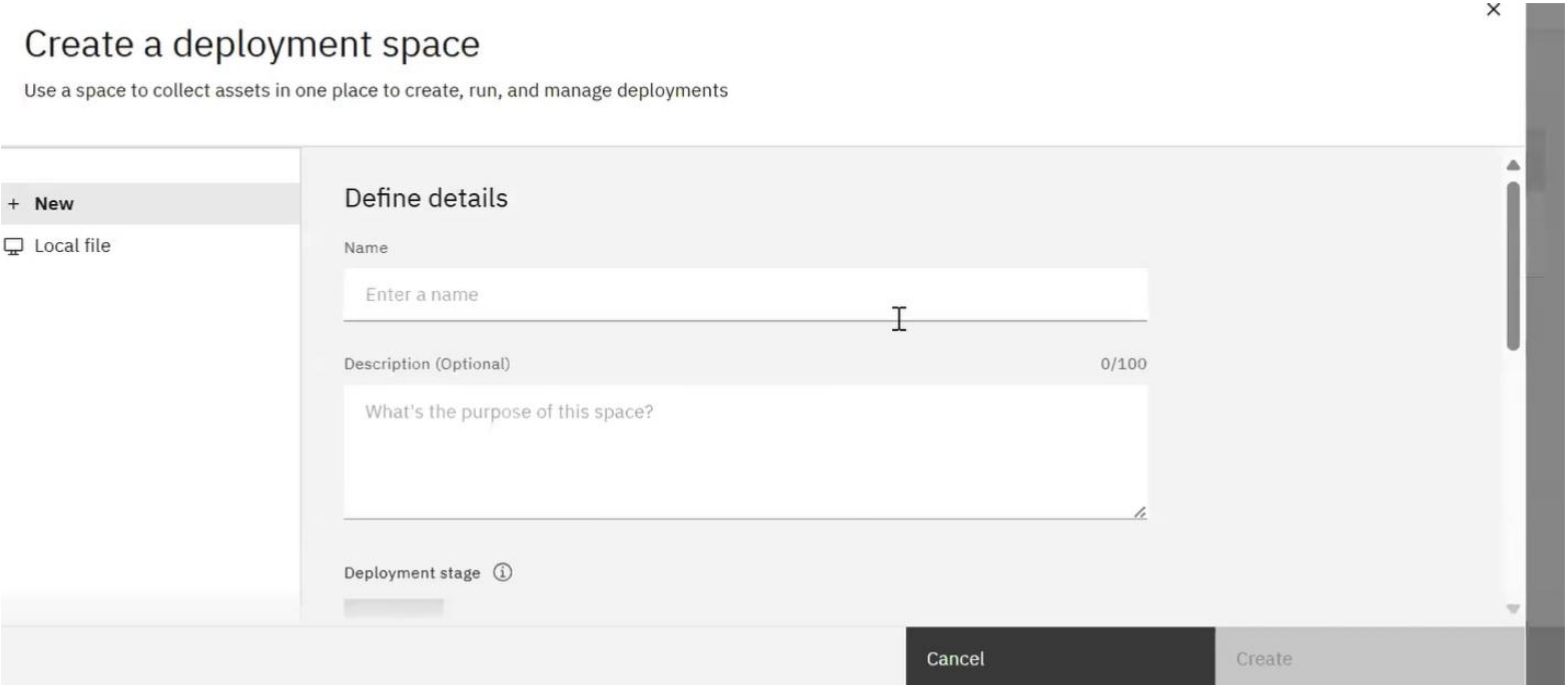
Experiment summary
Pipeline comparison
★ Rank by: Accuracy (Optimized) | Cross validation score
Progress map
Prediction column: Fault Type
Read dataset
Split holdout data
Read training data
Preprocessing
Model selection
Snap Logistic Regression
Random Forest Classifier
Hyperparameter optimization
Feature engineering
Hyperparameter optimization
Ensemble creation
P1
P2
P3
P4
P5
P6
P7
P8
P9
Relationship map
Swap view
Experiment completed
9 PIPELINES GENERATED
9 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 3 minutes
View log
Save code

RESULT

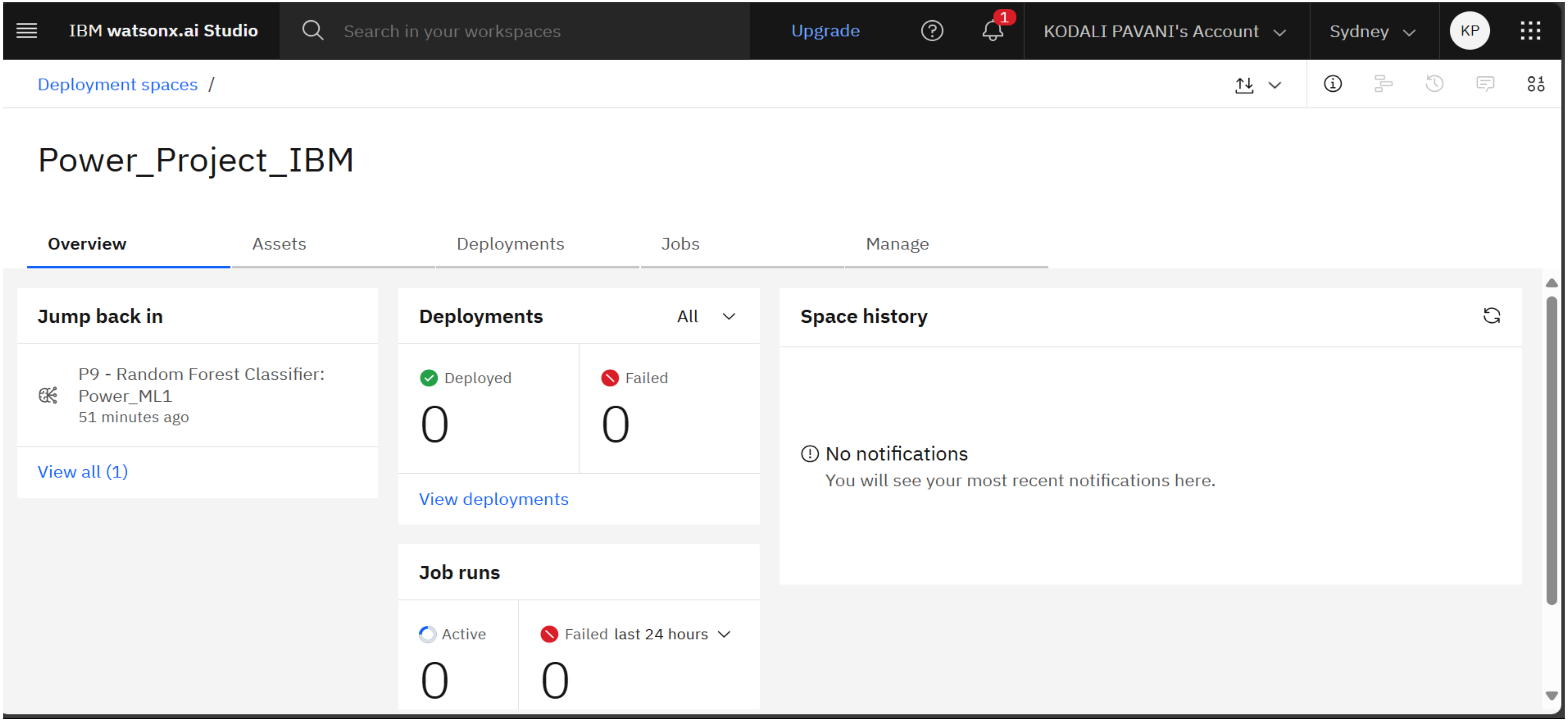


edunet foundation

RESULT

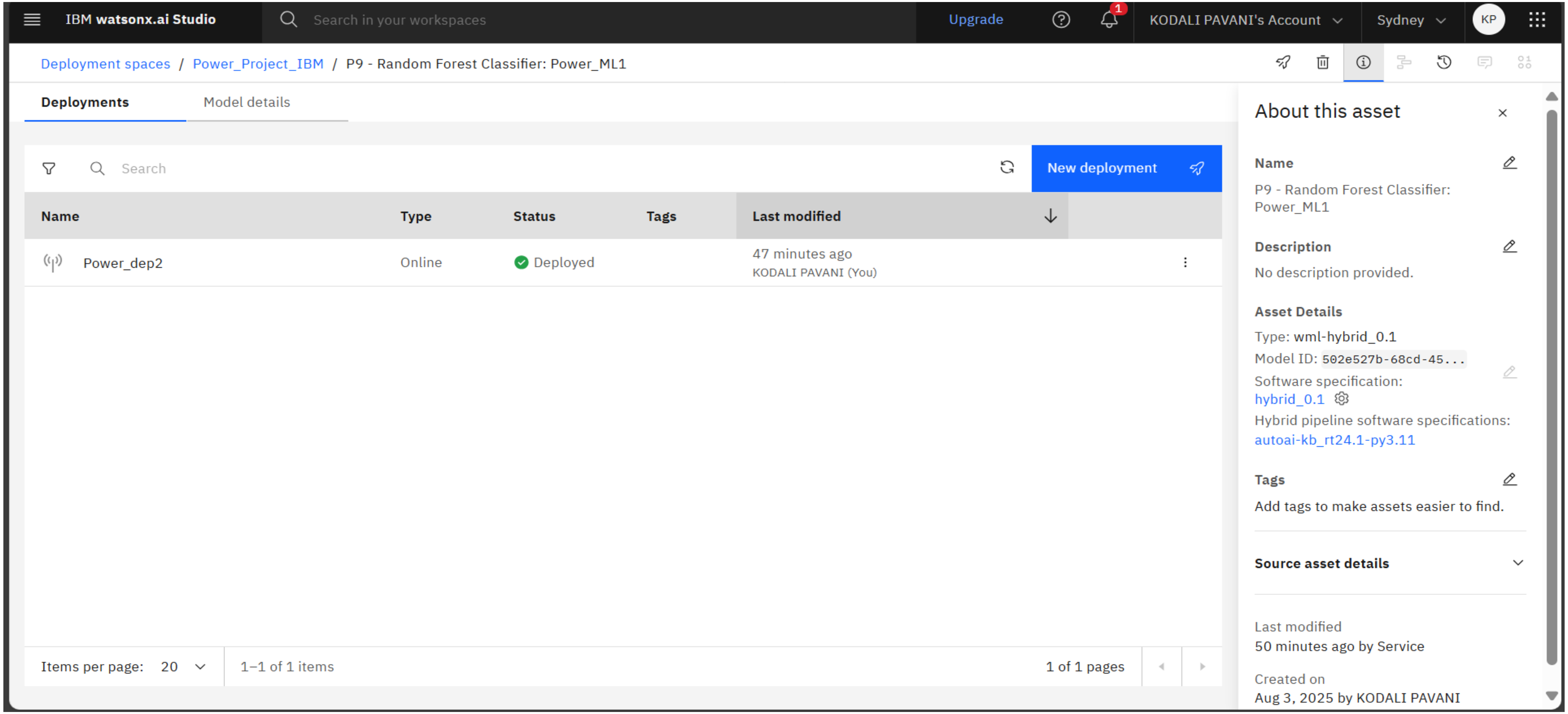

Create a deployment space
Use a space to collect assets in one place to create, run, and manage deployments
+ New
Local file
Define details
Name
Enter a name
Description (Optional)
0/100
What's the purpose of this space?
Deployment stage
Cancel
Create

RESULT



edunet foundation

RESULT


IBM watsonx.ai Studio
Search in your workspaces
Upgrade
KODALI PAVANI's Account
Sydney
KP
Deployment spaces / Power_Project_IBM / P9 - Random Forest Classifier: Power_ML1
Deployments
Model details
Search
New deployment
Name
Type
Status
Tags
Last modified
Power_dep2
Online
Deployed
47 minutes ago
KODALI PAVANI (You)
Items per page: 20
1–1 of 1 items
1 of 1 pages
About this asset
Name
P9 - Random Forest Classifier: Power_ML1
Description
No description provided.
Asset Details
Type: wml-hybrid_0.1
Model ID: 502e527b-68cd-45...
Software specification:
hybrid_0.1
Hybrid pipeline software specifications:
autoai-kb_rt24.1-py3.11
Tags
Add tags to make assets easier to find.
Source asset details
Last modified
50 minutes ago by Service
Created on
Aug 3, 2025 by KODALI PAVANI

IBM watsonx.ai Studio | Search in your workspaces | Upgrade | KODALI PAVANI's Account | Sydney | KP

Deployment spaces / Power_Project_IBM / P9 - Random Forest Classifier: Power_ML1 /

Power_dep2

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.

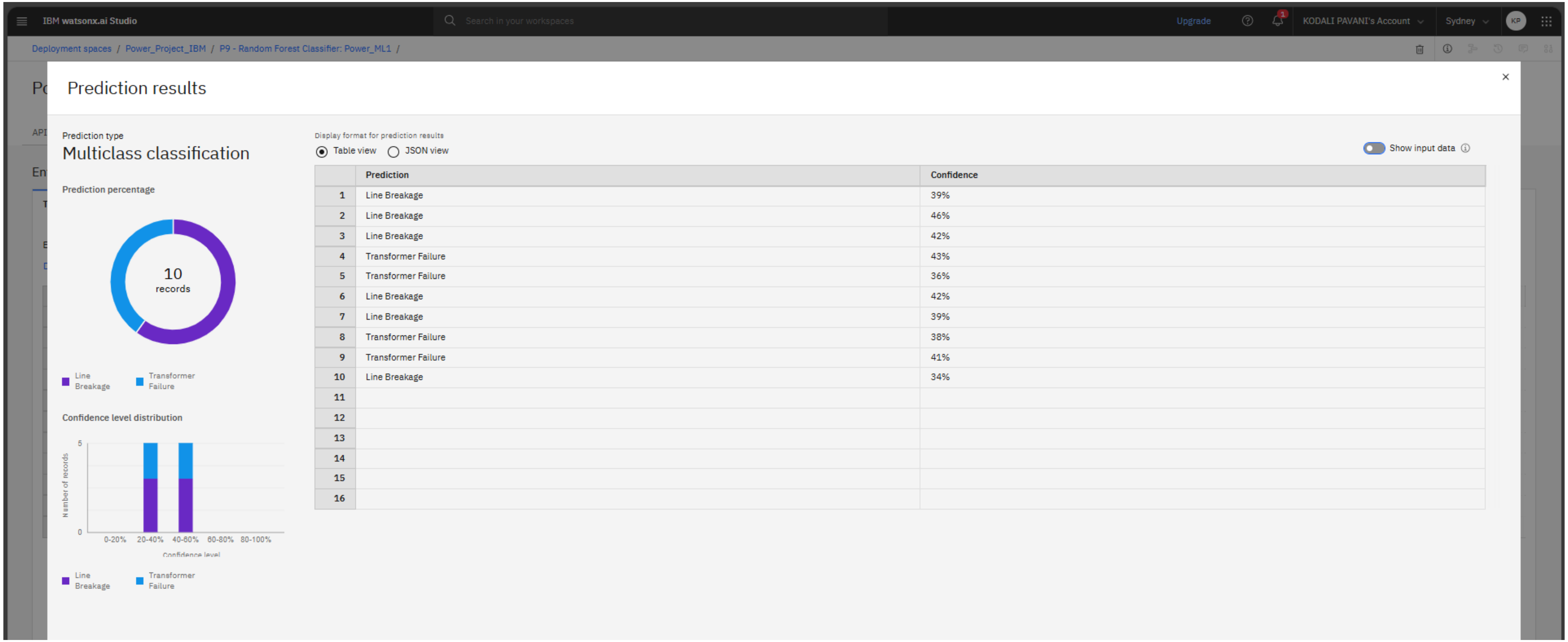
Download CSV template | Browse local files | Search in space | Clear all

	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) (d
4	F028	(34.7606, -118.9892)	1860	246	49	36	13
5	F026	(34.9593, -118.9408)	2010	197	47	35	15
6	F051	(34.6747, -118.6695)	2091	245	51	24	27
7	F058	(34.9126, -118.4003)	2093	202	52	25	26
8	F061	(34.1883, -118.5957)	1983	187	52	38	13

10 rows, 12 columns

Predict

RESULT


IBM watsonx.ai Studio
Search in your workspaces
Upgrade
KODALI PAVANI's Account
Sydney
Deployment spaces / Power_Project_IBM / P9 - Random Forest Classifier: Power_ML1 /
Prediction results
Prediction type
Multiclass classification
Prediction percentage
10
records
Line Breakage
Transformer Failure
Confidence level distribution
Number of records
5
0
0-20%
20-40%
40-60%
60-80%
80-100%
Confidence level
Line Breakage
Transformer Failure
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 Line Breakage 39%
2 Line Breakage 46%
3 Line Breakage 42%
4 Transformer Failure 43%
5 Transformer Failure 36%
6 Line Breakage 42%
7 Line Breakage 39%
8 Transformer Failure 38%
9 Transformer Failure 41%
10 Line Breakage 34%
11
12
13
14
15
16

CONCLUSION

- In this project, we designed and implemented a machine learning model capable of detecting and classifying different types of faults in a power distribution system using electrical measurement data (voltage and current phasors).
  The model effectively distinguishes between normal operating conditions and common fault scenarios such as line-to-ground, line-to-line, and three-phase faults.
  Experimental results show that the model achieves high accuracy and speed, which are critical for timely fault identification and response in modern power grids.
  This approach demonstrates how AI techniques can significantly enhance grid monitoring, fault analysis, and overall system reliability.

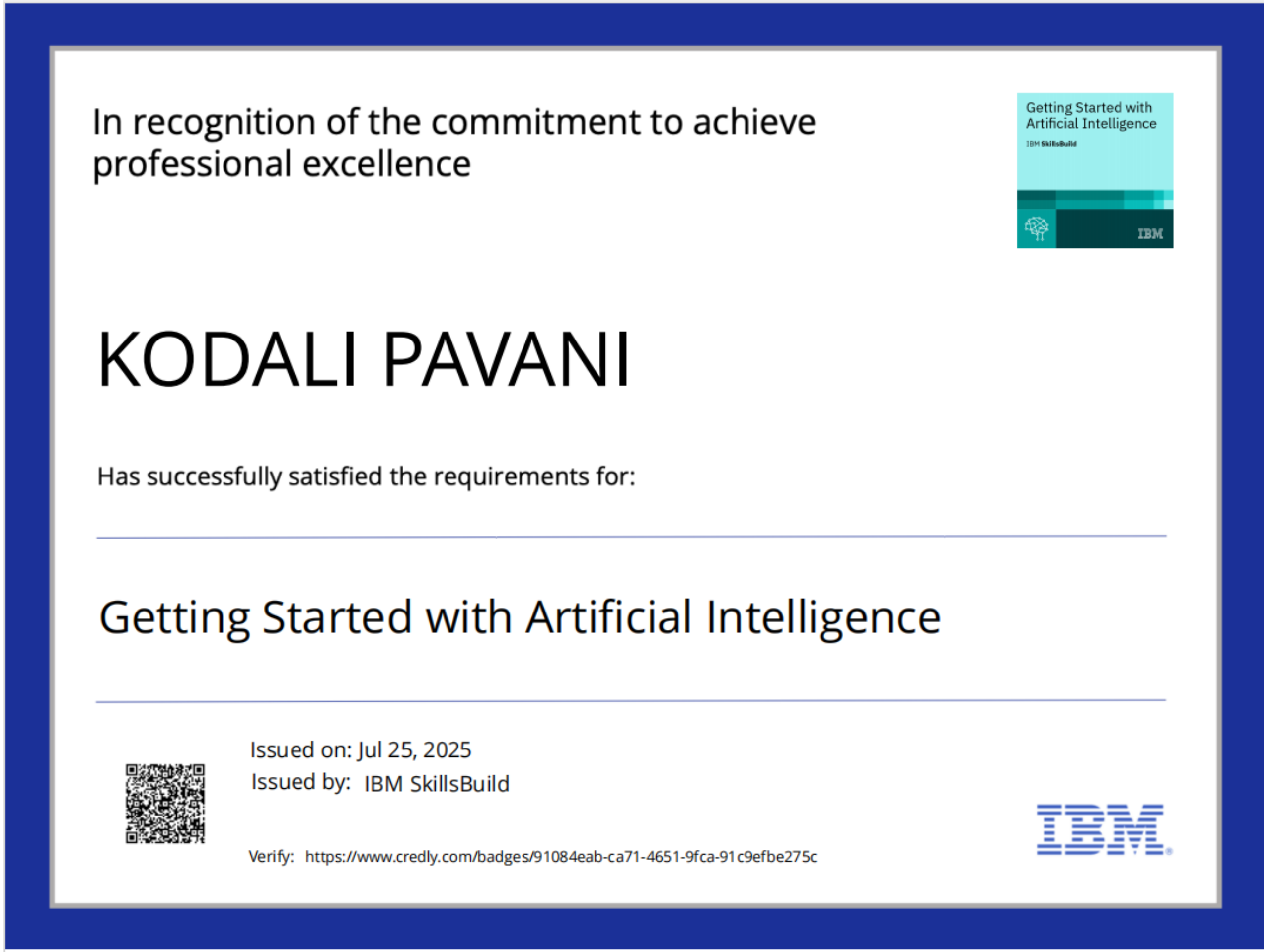
FUTURE SCOPE

- Real-time deployment: Integrate the model into real-time monitoring systems to automatically trigger protective measures.
- Expanded fault types: Extend the model to detect and classify additional complex faults, including simultaneous faults or high-impedance faults.
- Data augmentation: Use simulated and real field data to improve model generalization and robustness against noisy measurements.
- Hybrid models: Combine machine learning with signal processing or physics-based models for better interpretability and fault localization.
- Edge computing: Deploy lightweight models on substation or field devices for local, real-time detection without relying on central servers.
- Integration with smart grids: Link fault classification with automated restoration systems and demand response strategies to enhance grid resilience..

REFERENCES

- List and cite relevant sources, research papers, and articles that were instrumental in developing the proposed solution. This could include academic papers on bike demand prediction, machine learning algorithms, and best practices in data preprocessing and model evaluation.

IBM CERTIFICATIONS


In recognition of the commitment to achieve professional excellence

Getting Started with Artificial Intelligence
IBM SkillsBuild

KODALI PAVANI

Has successfully satisfied the requirements for:

Getting Started with Artificial Intelligence

Issued on: Jul 25, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/91084eab-ca71-4651-9fca-91c9efbe275c

IBM

IBM CERTIFICATIONS


In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution

IBM SkillsBuild

IBM

KODALI PAVANI

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 25, 2025

Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/007f3f50-825c-4149-8d58-73ee9d6331c4

IBM

IBM CERTIFICATIONS

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

KODALI PAVANI

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