CAPSTONE PROJECT

POWER SYSTEM FAULT DETECTION AND CLASSIFICATION USING MACHINE LEARNING

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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

Faults in power distribution systems threaten grid stability and service reliability. This project develops a machine learning model to detect and classify faults using voltage and current phasor data. The model will distinguish between normal and fault conditions—such as LG, LL, and LLL faults—based on time-series analysis. This approach aims to enhance the speed and accuracy of fault diagnosis, improving grid resilience and operational efficiency.

PROPOSED SOLUTION

- **Develop a machine learning model** that classifies power system faults using the dataset provided. The model will process electrical measurements to identify the type of fault rapidly and accurately.This classification will help automate fault detection and assist in quicker recovery actions, ensuring system reliability.
- **Key components:**
- **Data Collection:** Use the Kaggle dataset on power system faults.
- **Preprocessing:** Clean and normalize the dataset.
- **Model Training:** Train a classification model (e.g., Decision Tree, Random Forest, or SVM).
- **Evaluation:** Assess model performance using metrics such as accuracy, precision, recall, and F1-score.

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:

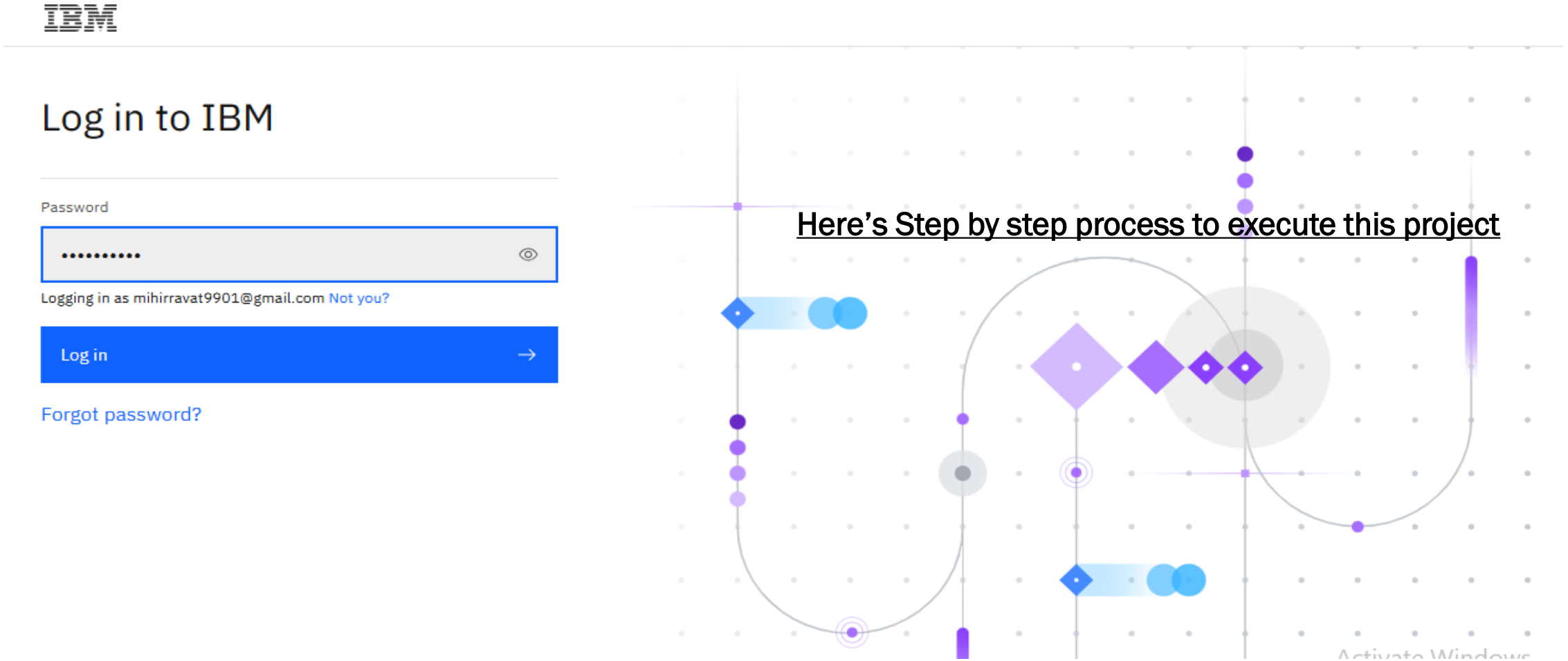
- **System requirements**:
- IBM Cloud (mandatory)
- IBM Watson Studio for model development and deployment
- IBM Cloud Object Storage for dataset handling

ALGORITHM & DEPLOYMENT

- **Algorithm Selection:**
  Random Forest Classifier (or SVM based on performance)
- **Data Input:**
  Voltage, current, and phasor measurements from the dataset
- **Training Process:**
  Supervised learning using labeled fault types
- **Prediction Process:**
  Model deployed on IBM Watson Studio with API endpoint for real-time predictions

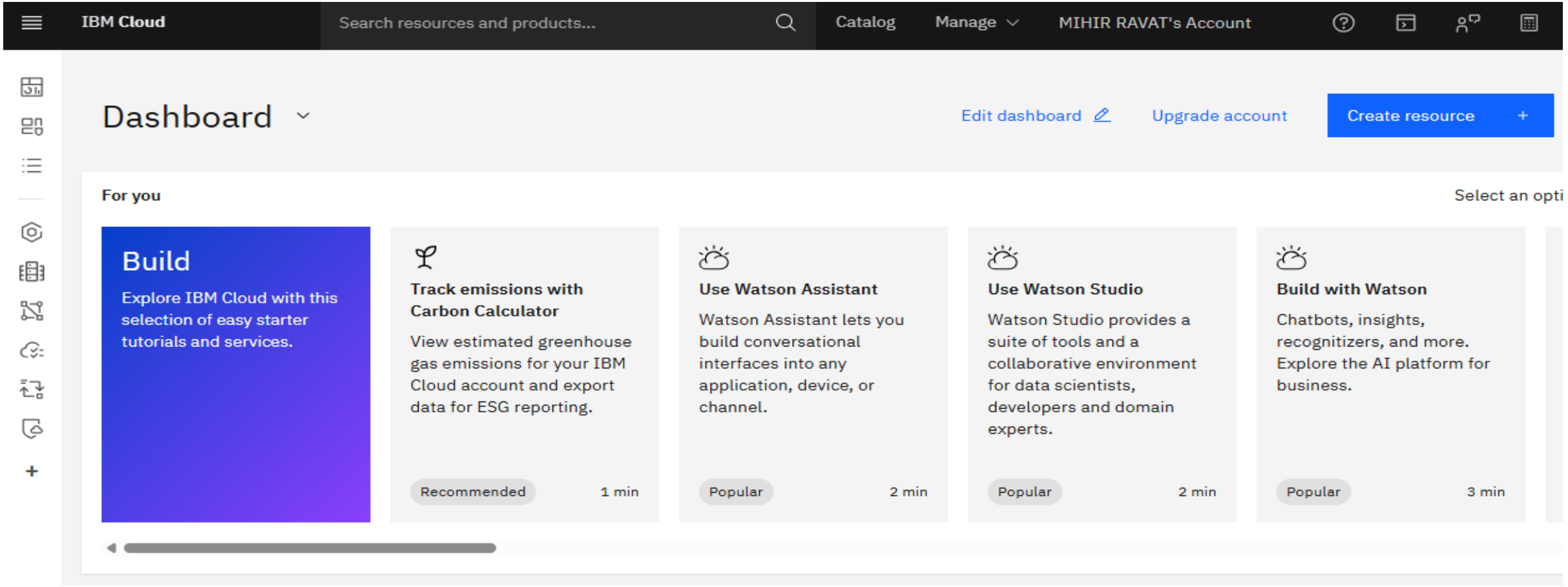
RESULT

- Step1: Open IBM Cloud login page with this link **cloud.ibm.com**, enter your Gmail and password and click on **login**



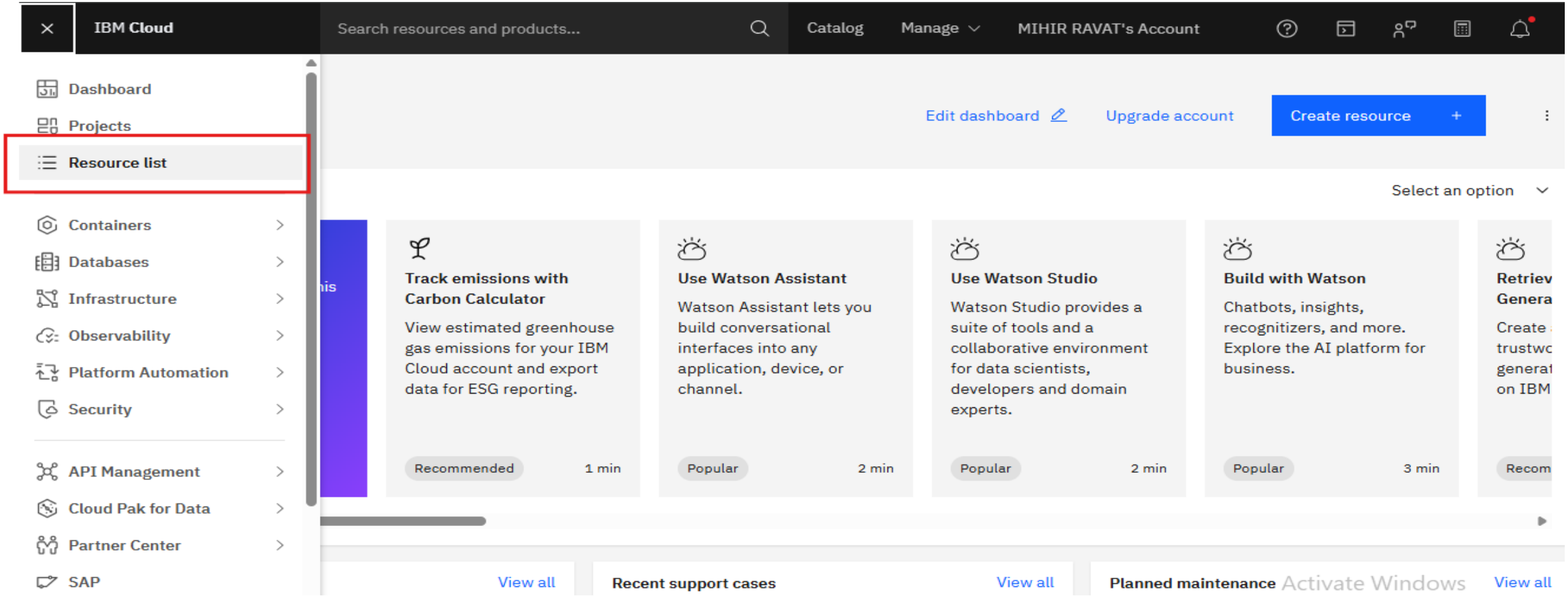
RESULT

This is IBM cloud dashboard



RESULT

Step2 : Click on Navigation menu, go to **Resources list** and clear all the resources



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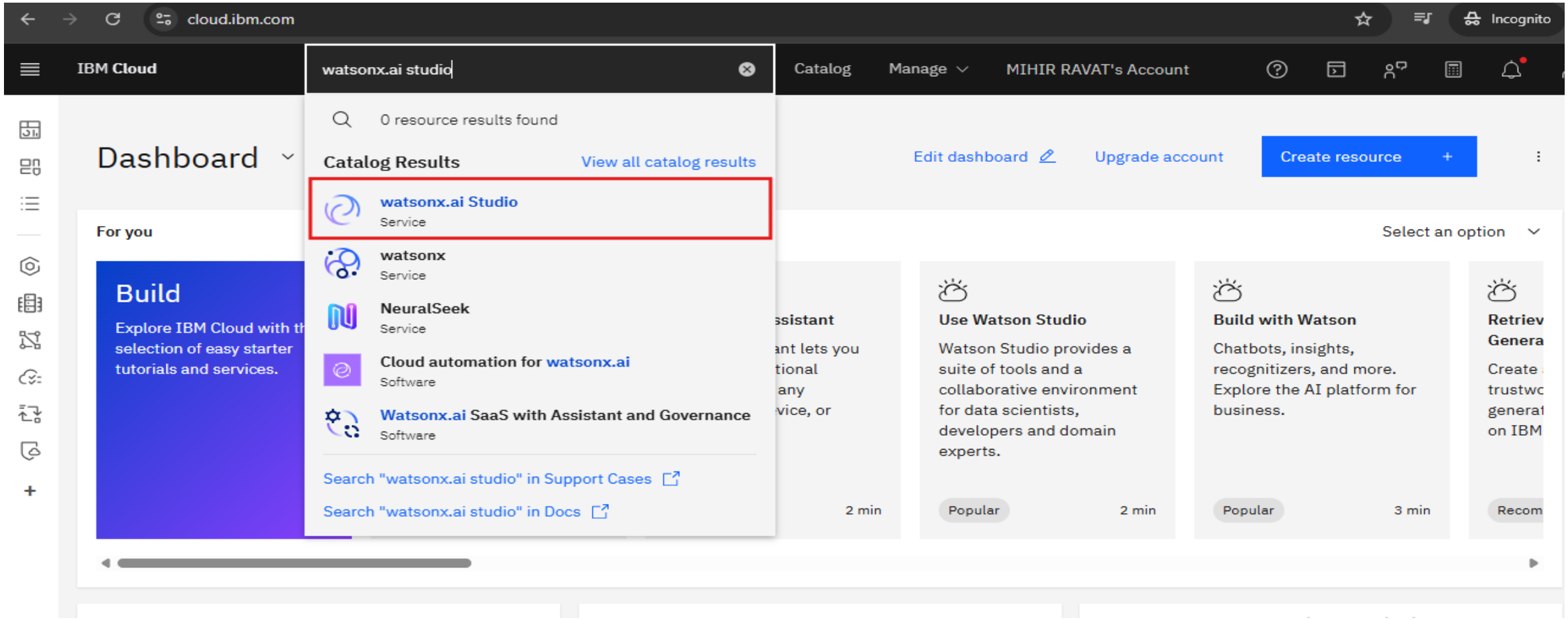
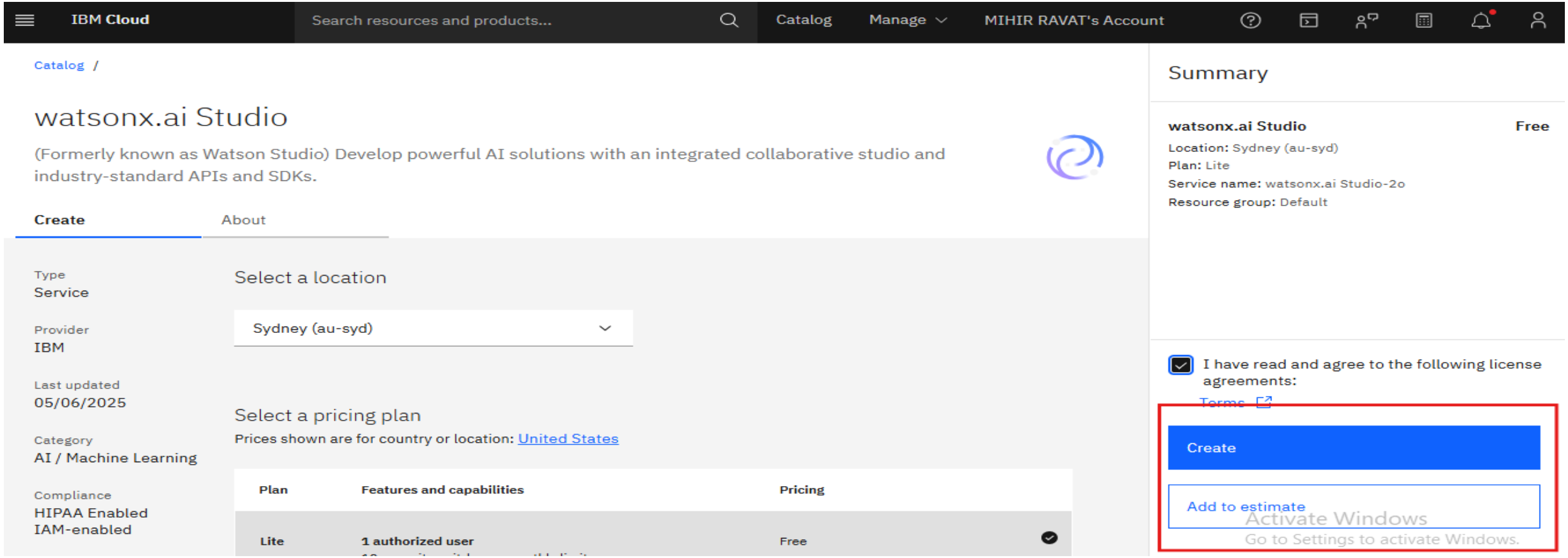
RESULT

Step 3:Click on search icon and type "**Watsonx.ai studio**". Select Watsonx.ai studio(Service).



RESULT

Step 4: Click on the check box and Create



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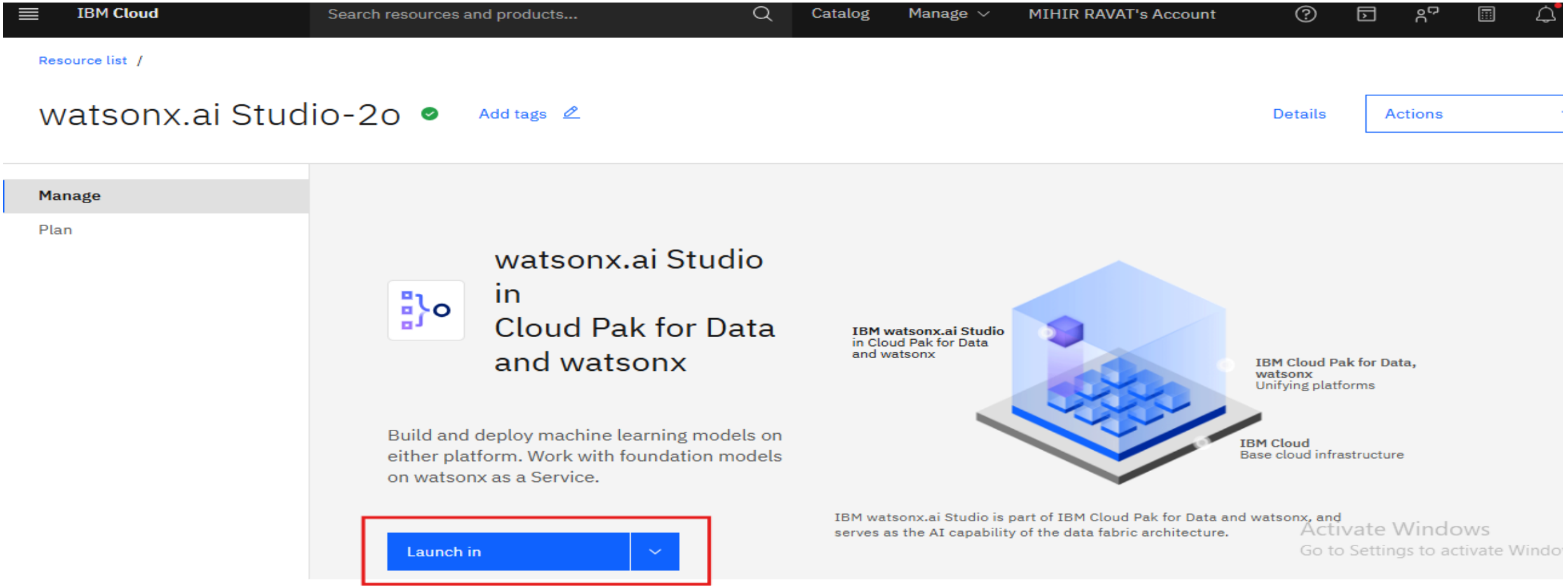
RESULT

Step 5: Click on the Launch in



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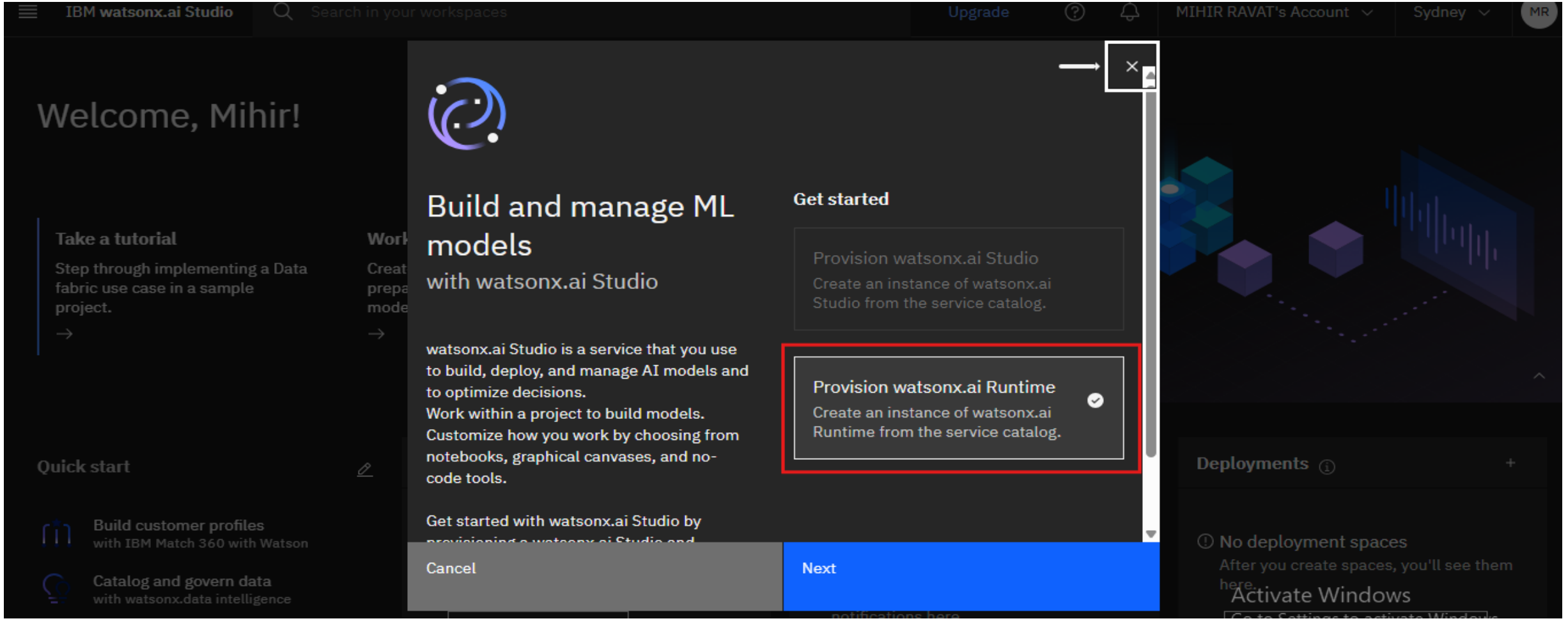
RESULT

Step 6: Select Provision Watsonx.ai Runtime and click on Next.



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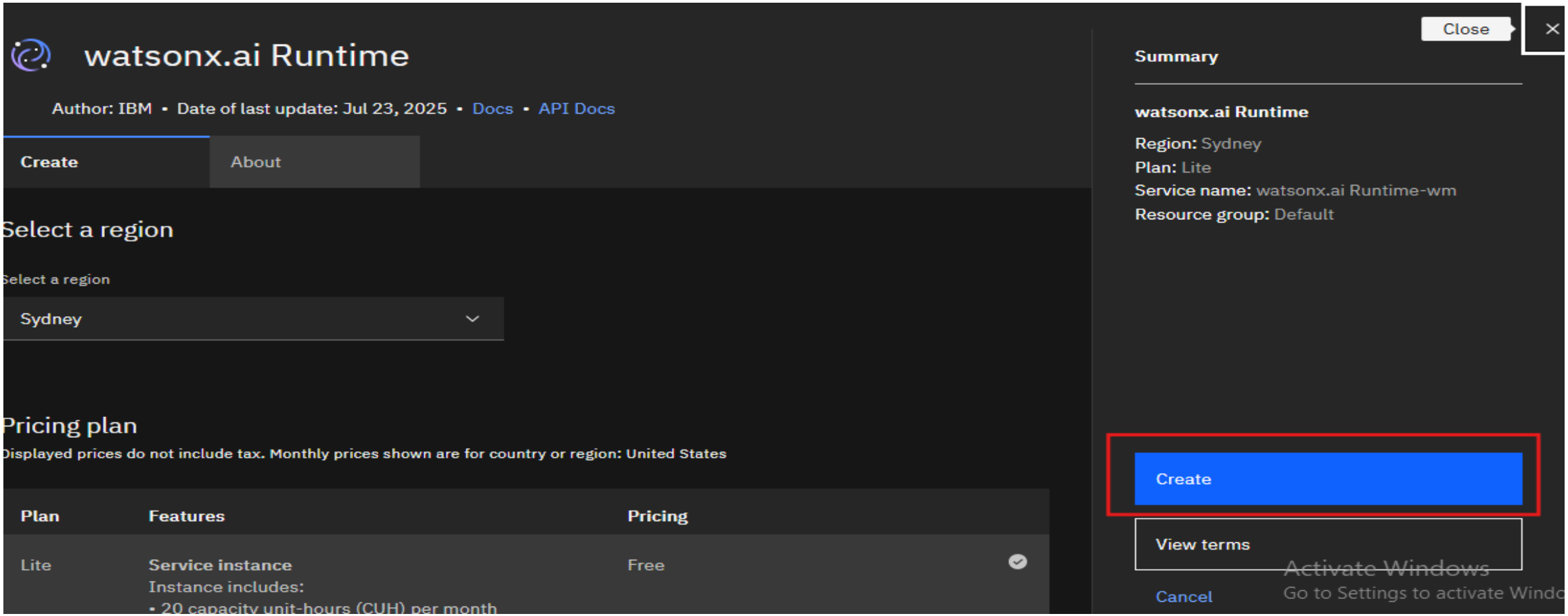
RESULT

Step 7: Click on create



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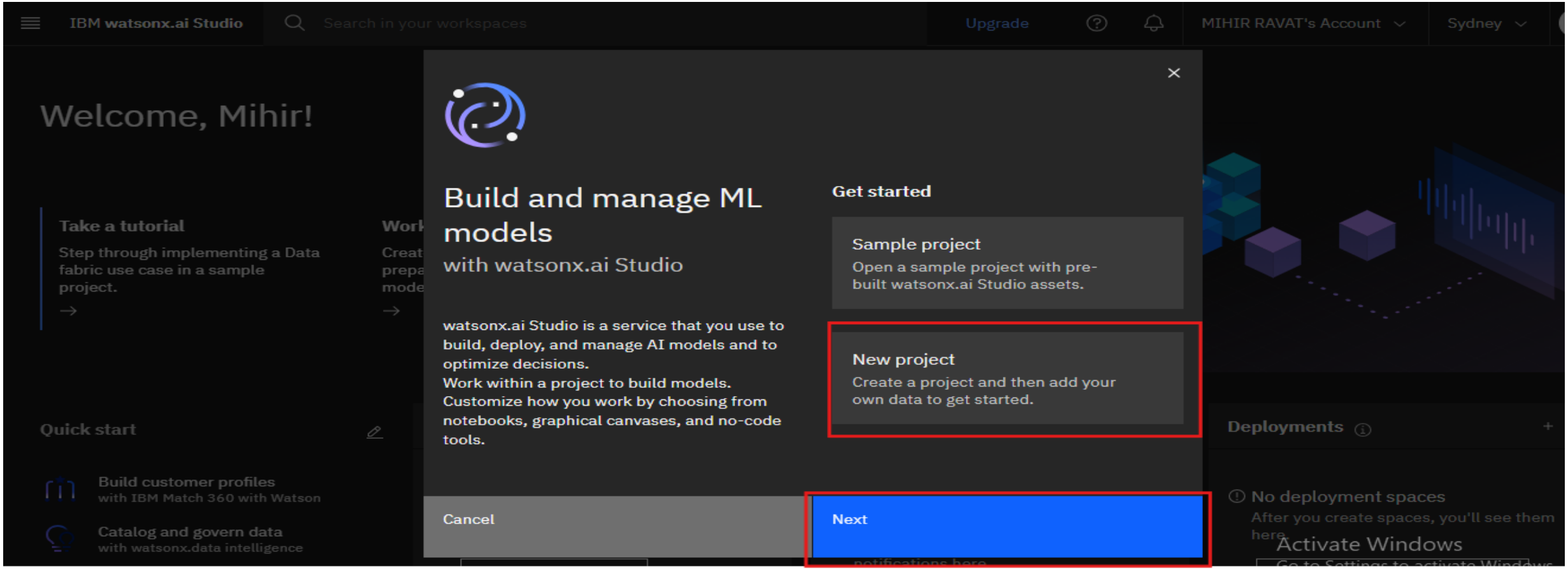
RESULT

Step 8: Select New project and click on Next



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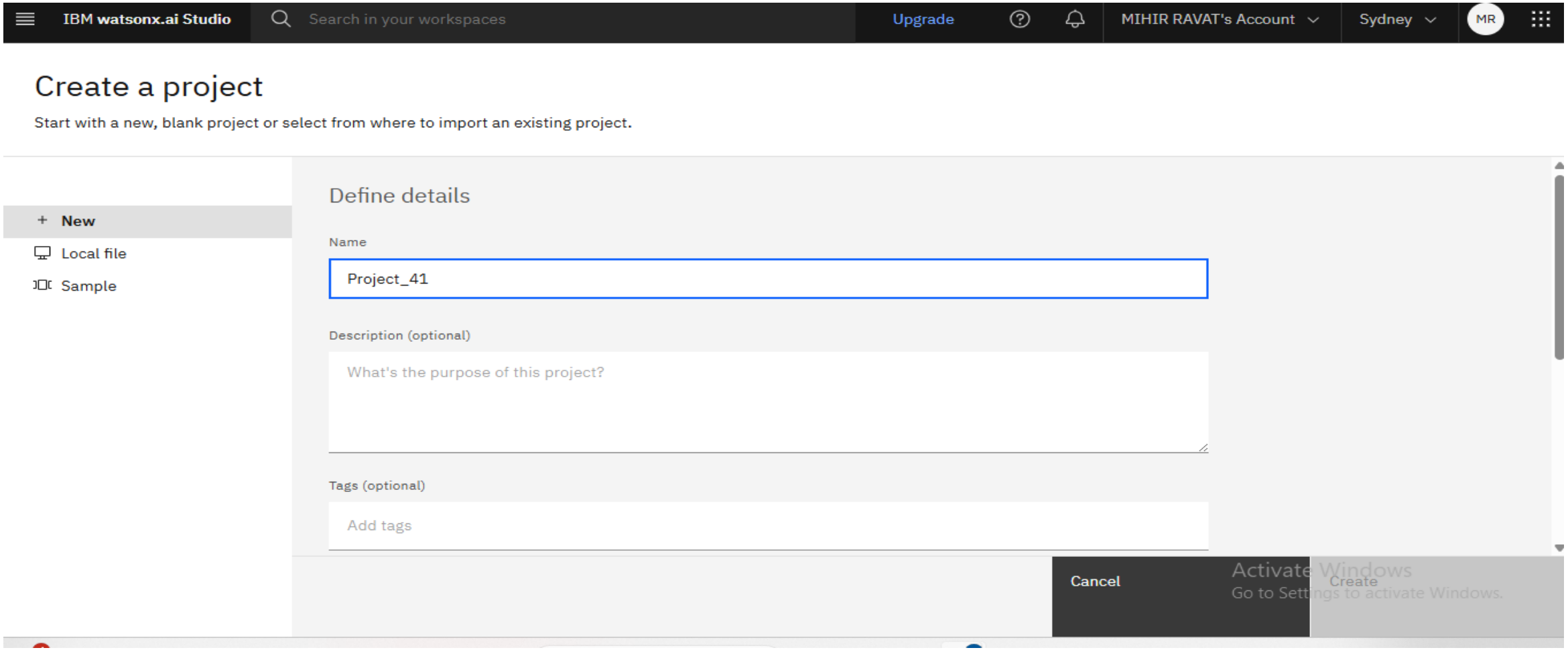
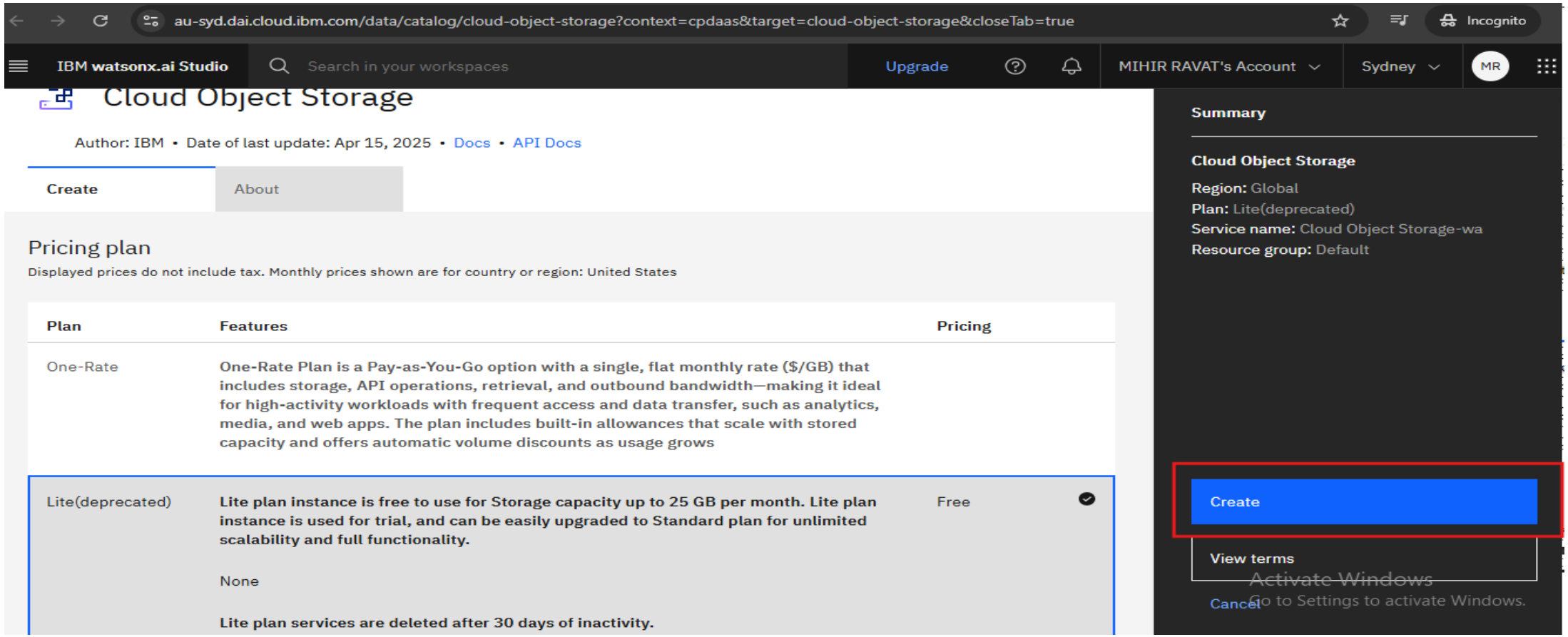
RESULT

Step 9: Enter project name and scroll a little.



RESULT

Step10: Select storage service and **Click on Add ,**then select **Free plan** and **Click on continue**



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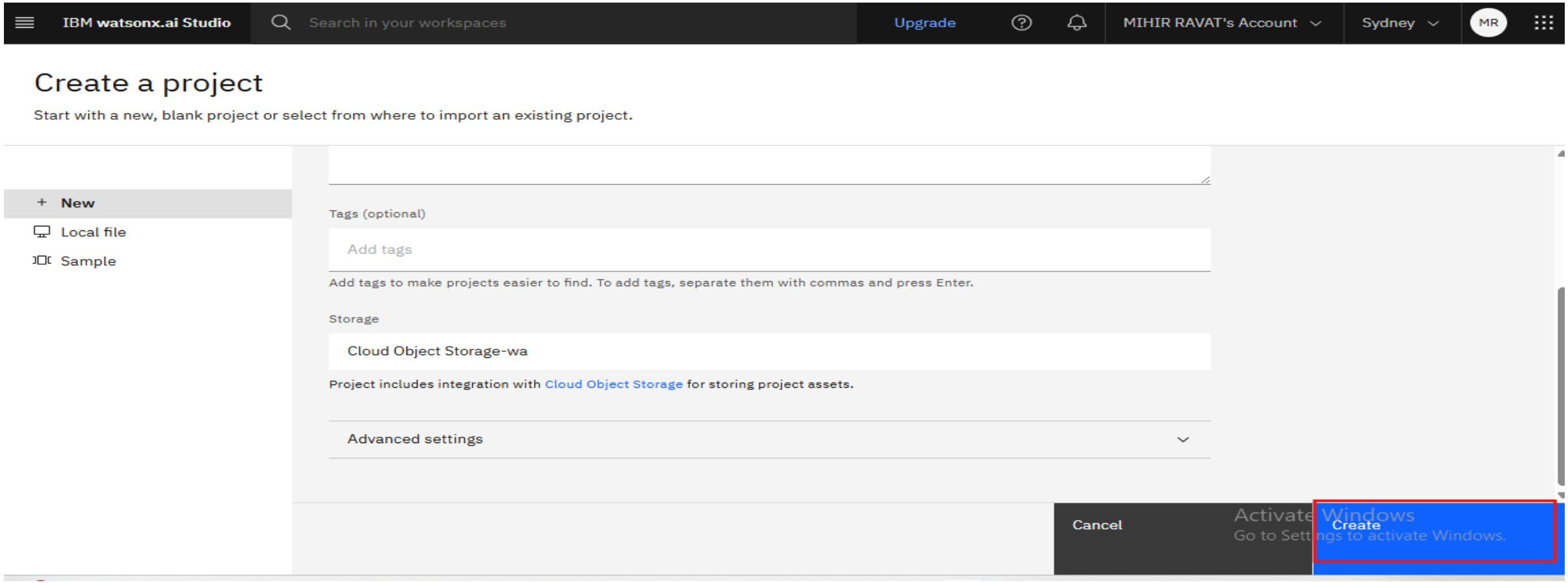
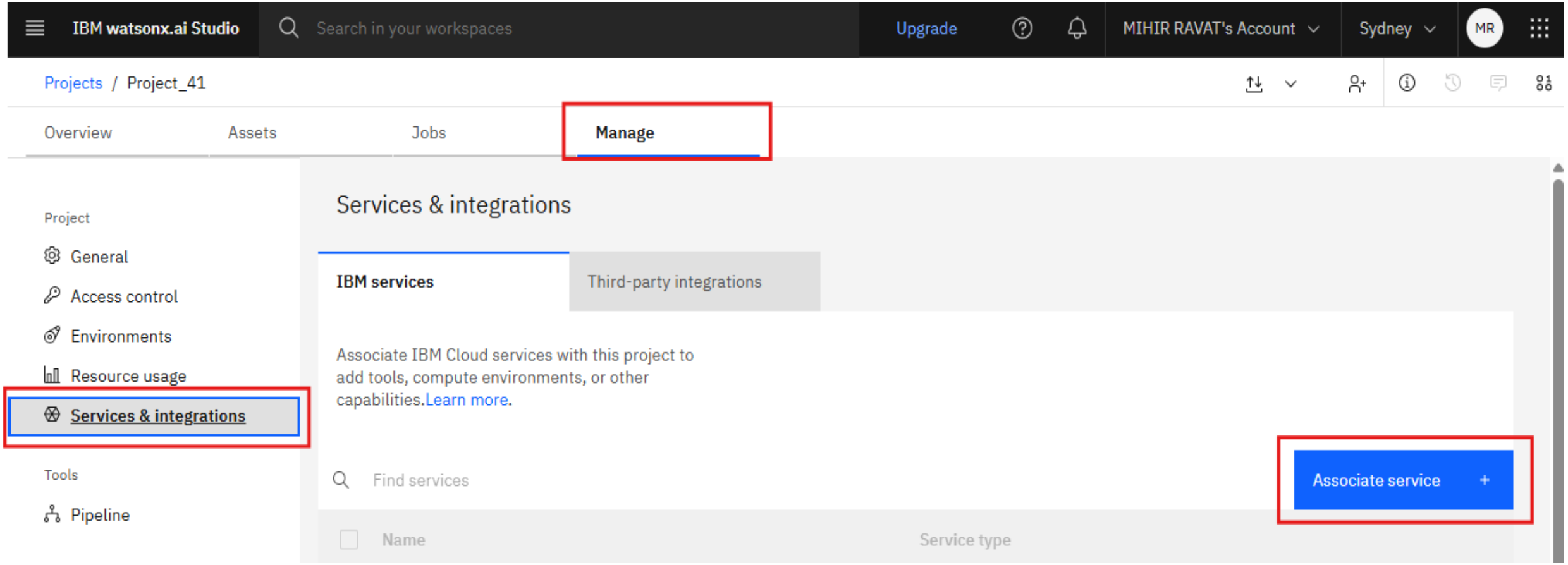
RESULT

Step 11:Click on refresh then click on **Create**



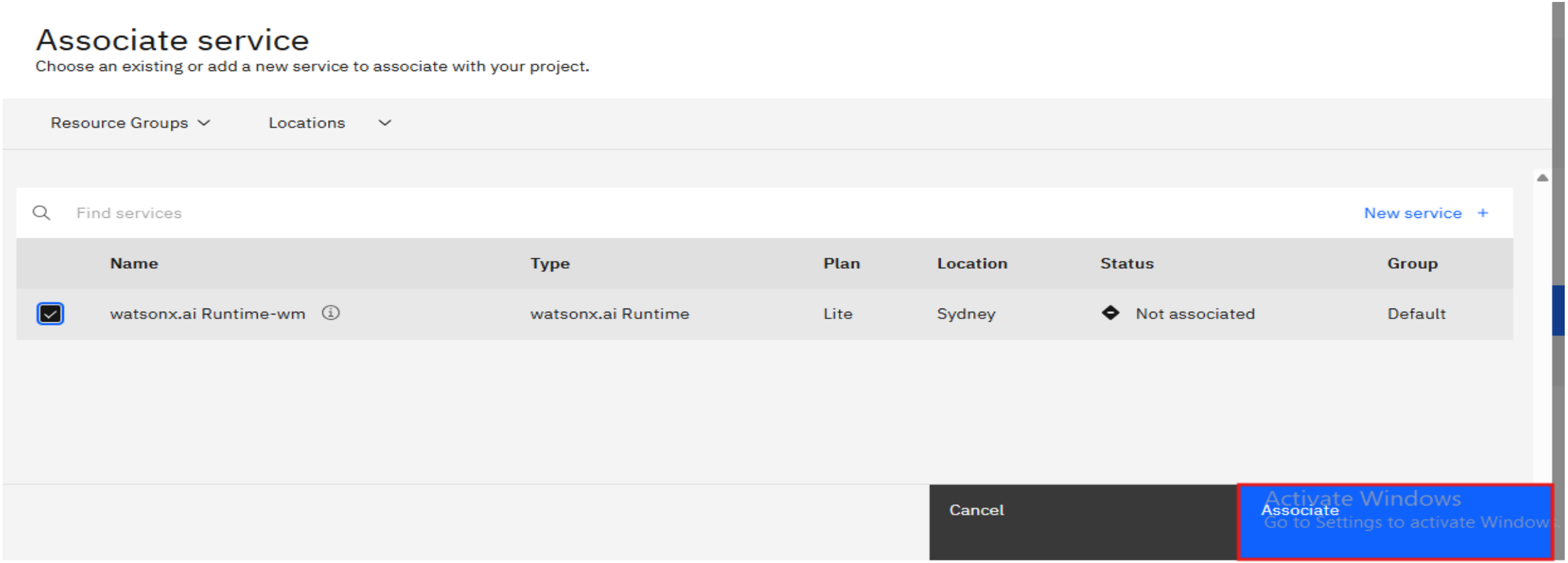
RESULT

Step 12: Click on the **Manage**,Under Manage tab click on **Services & integrations** and click on **Associate service**.



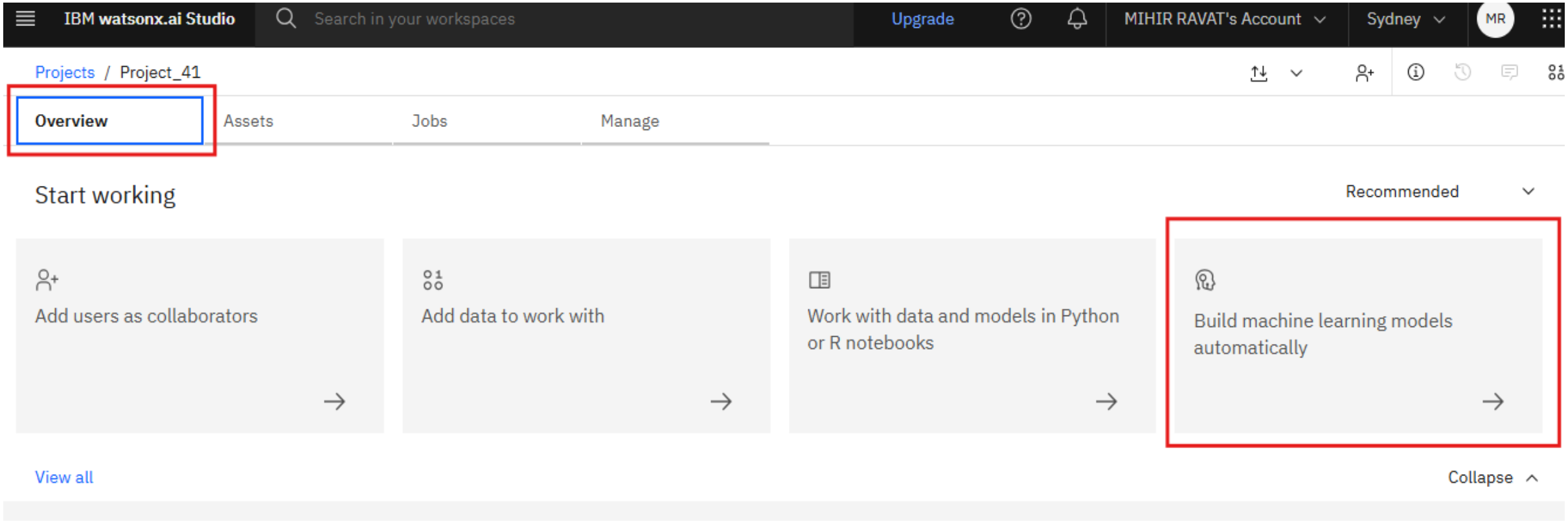
RESULT

Step 13: Click on the Watsonx.ai Runtime and Associate



RESULT

Step 14:Click on **Overview** and then Click on "**Build machine learning models automatically**"



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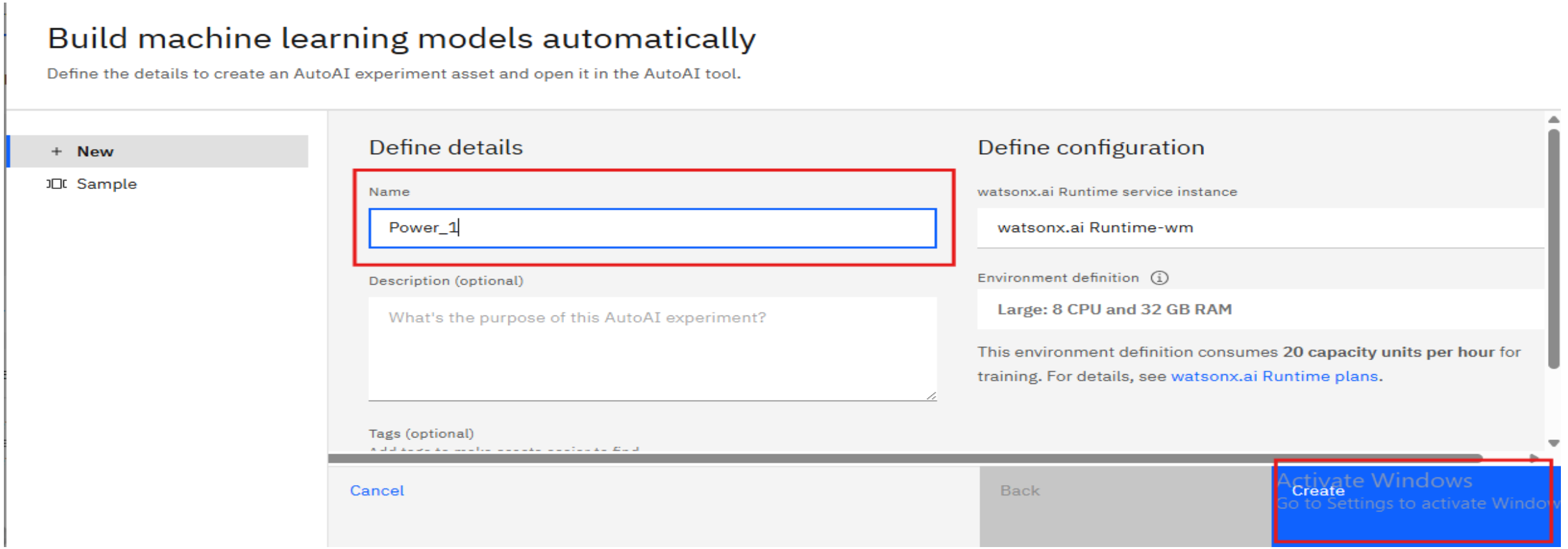
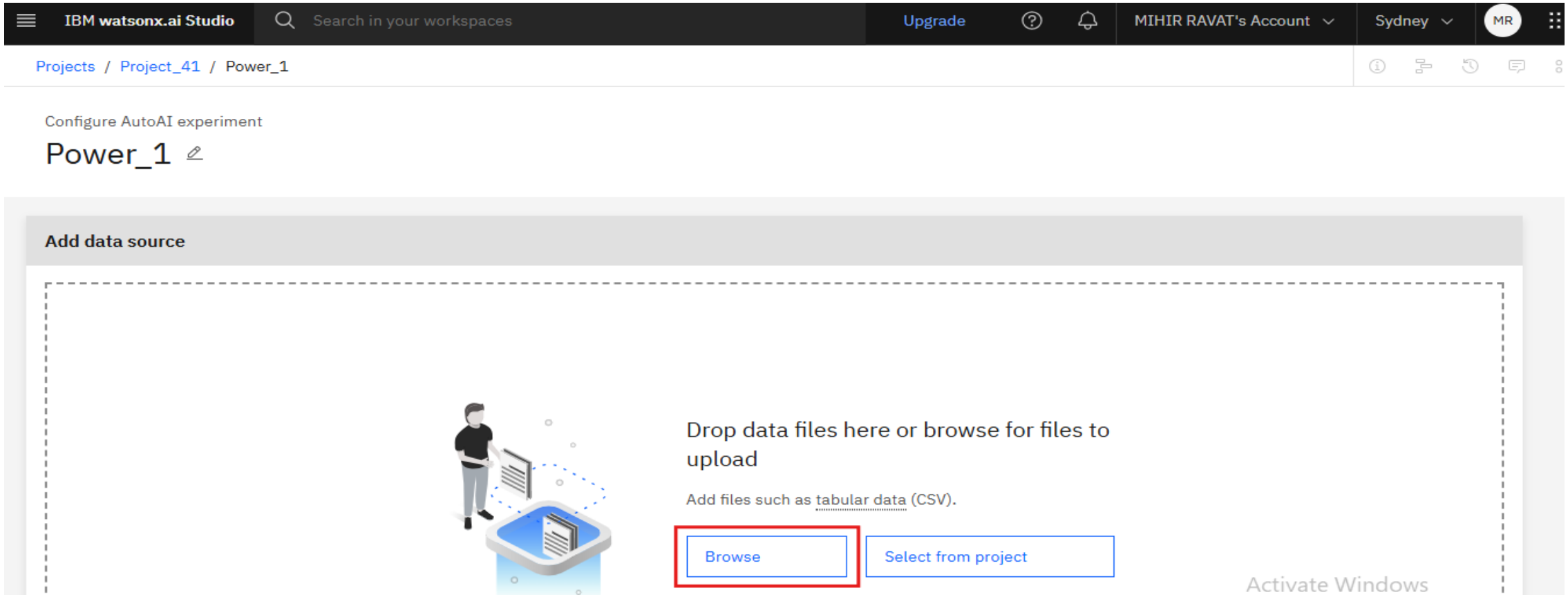
RESULT

Step 15: Enter experiment name and click on **Create**



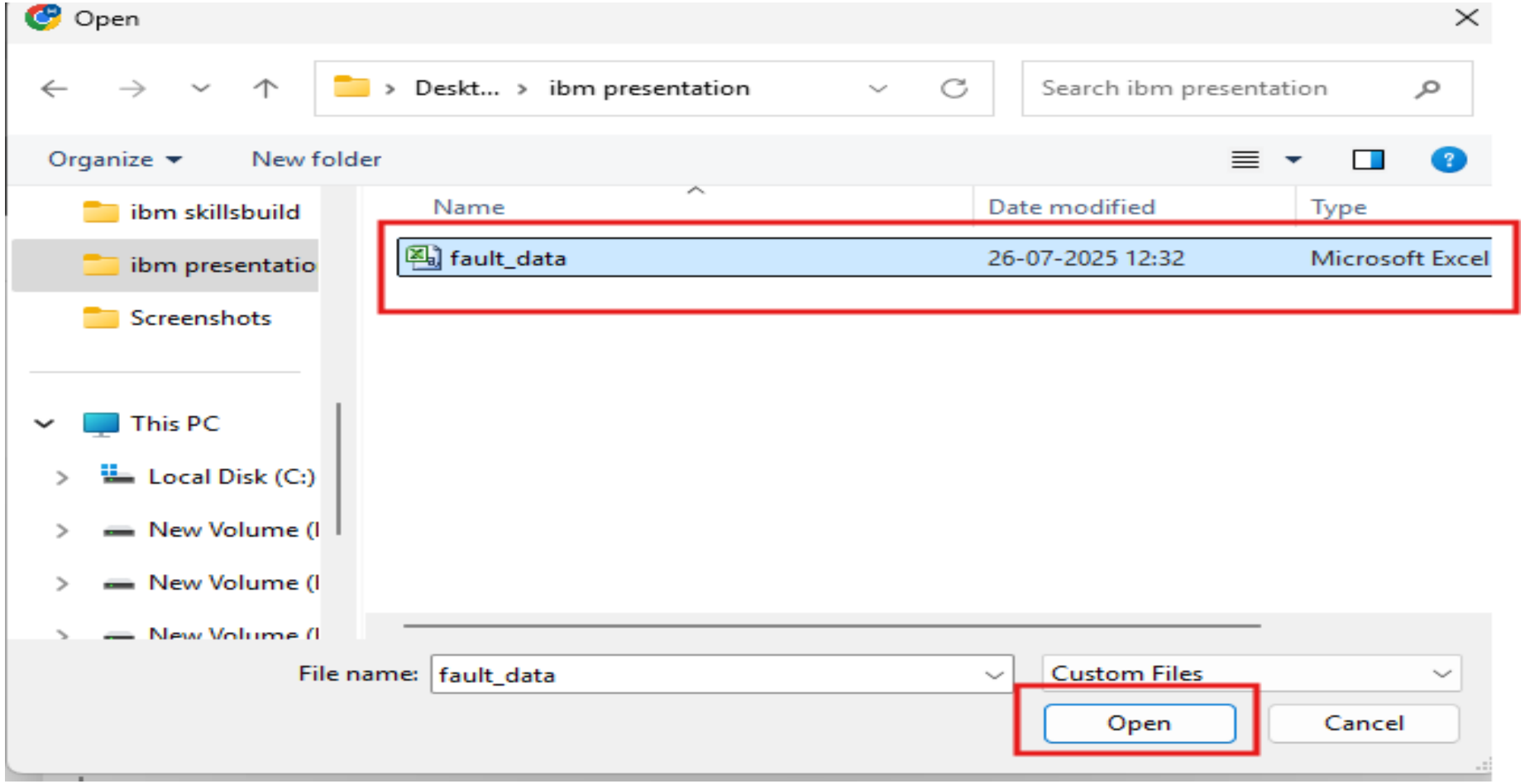
RESULT

Step 16: Add the downloaded data set (fault_data.csv) with the help of Browse option



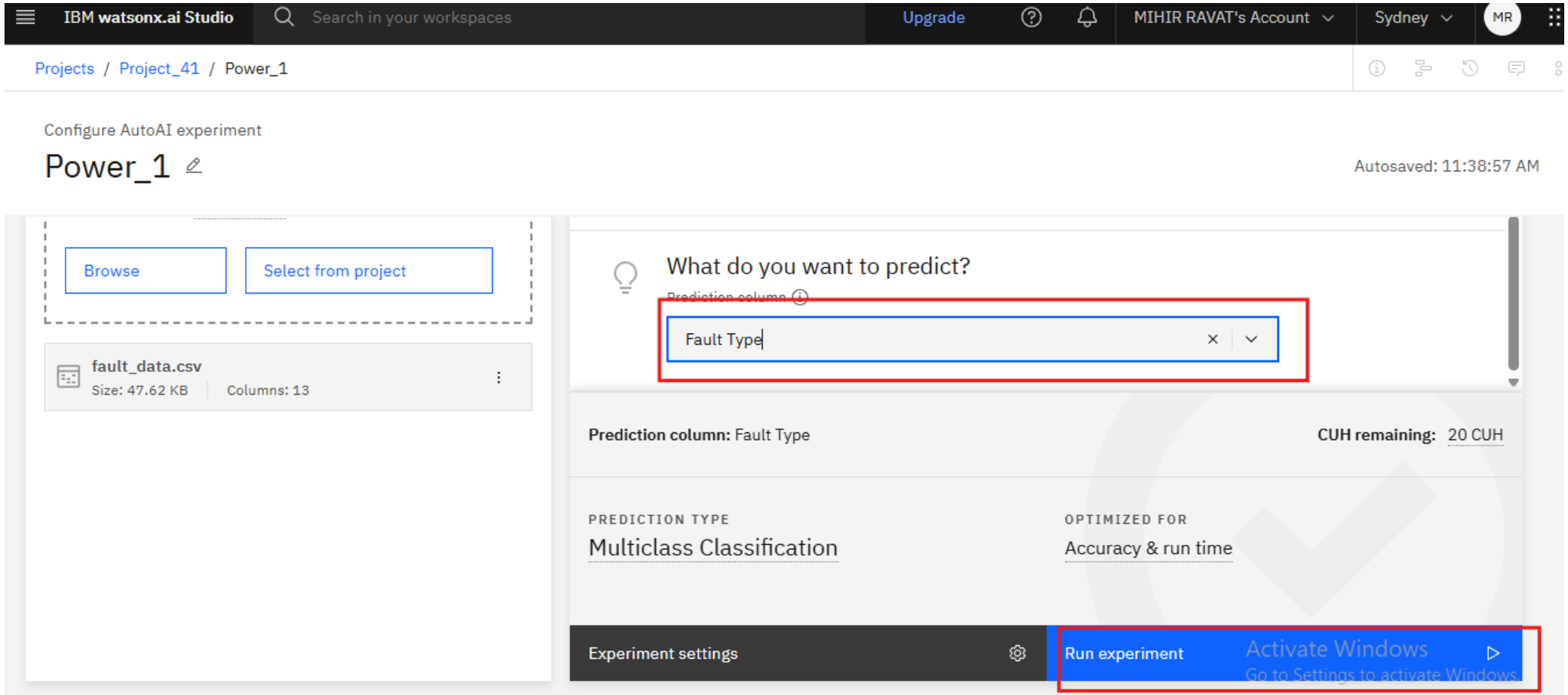
RESULT

Step 17: Select the data set and click on Open



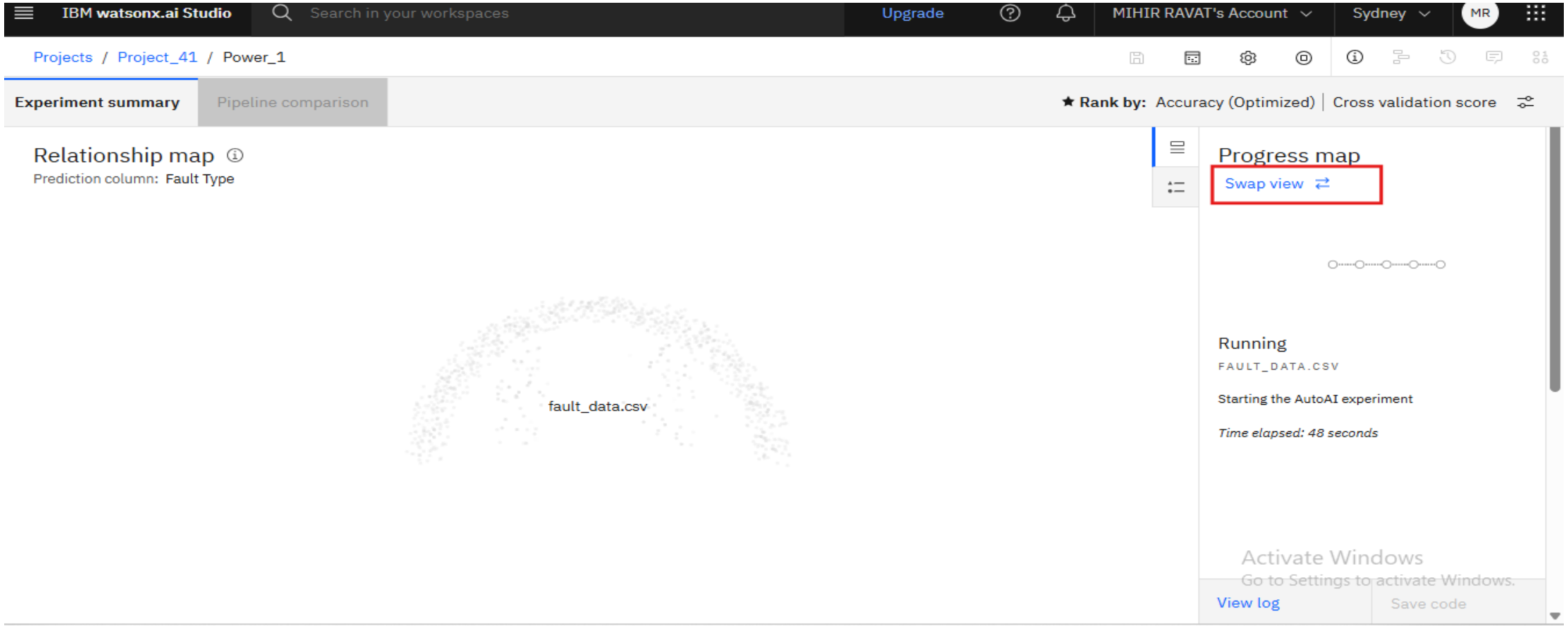
RESULT

Step 18: Data set is loaded. In create a time series analysis? Choose **No** option, Choose prediction column.(Fault_Type) and click on run experiment



RESULT

Step 19: Auto AI experiment is running. Now click on swap view



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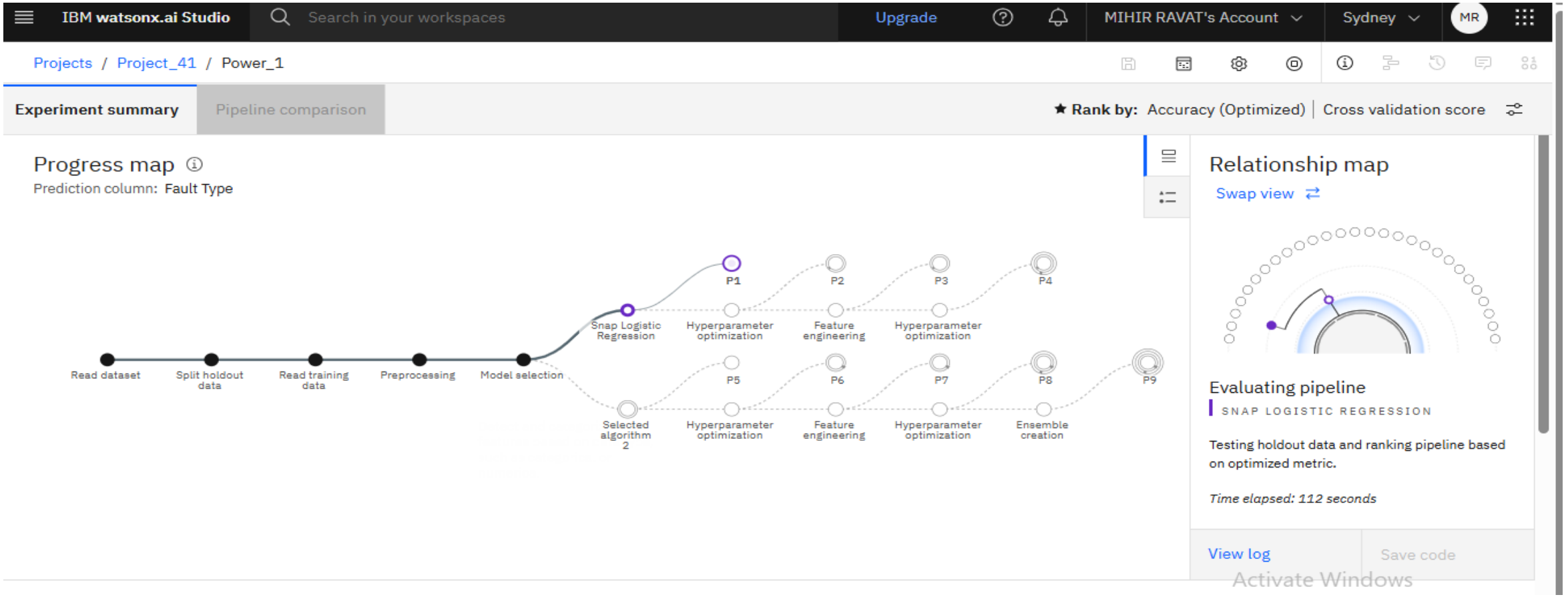
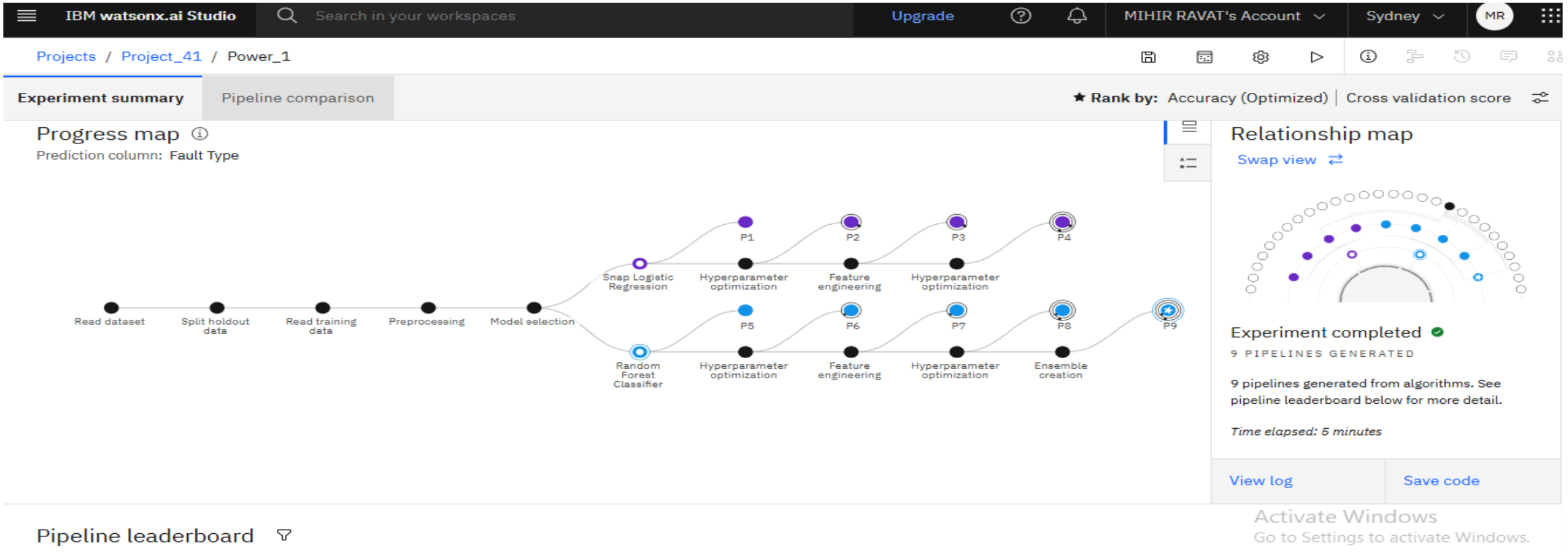
RESULT

Pipelines are building



RESULT

The experiment is completed



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RESULT

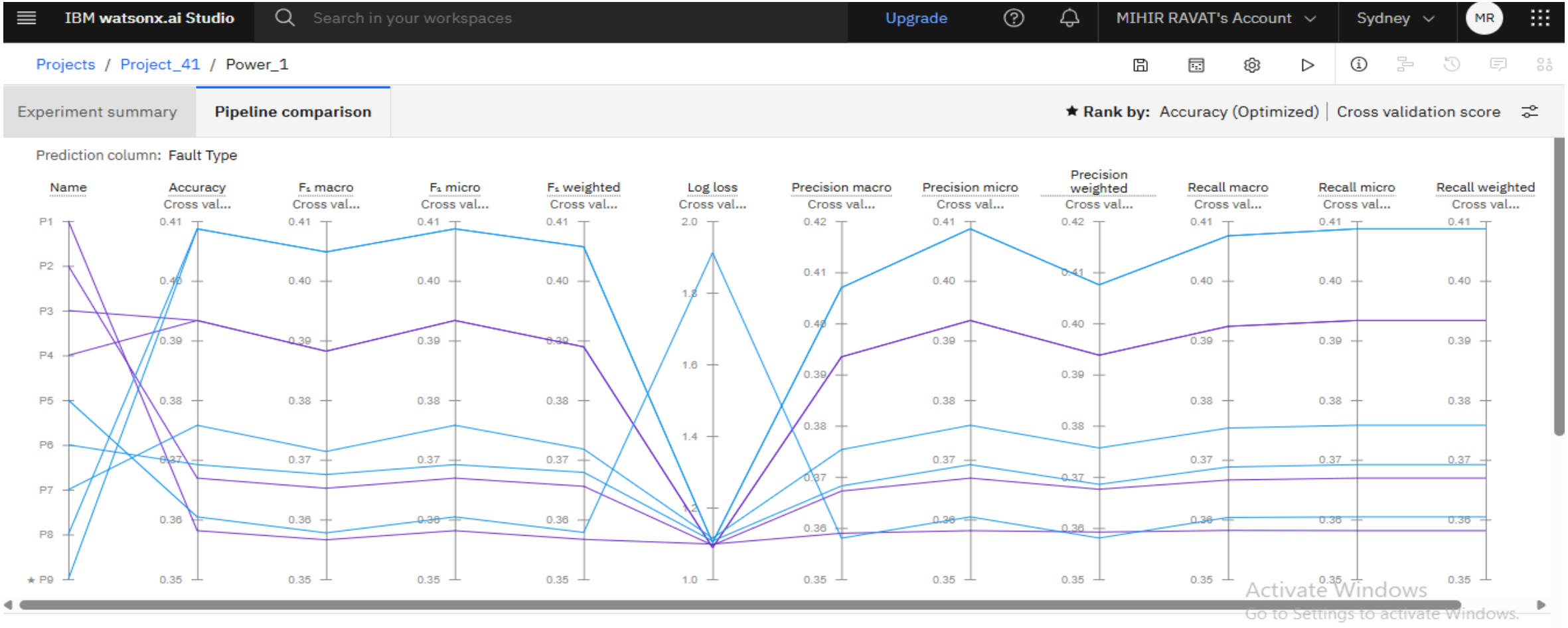
This is the pipeline leader board. In this Pipeline9 is the top performer along with the algorithm name i.e. Batched Tree Ensemble Classifier(Random Forest Classifier).

Pipeline leaderboard

	Rank	Name	Algorithm	Specialization	Accuracy (Optimized) Cross Validation	Enhancements	Build time
★	1	Pipeline 9	Batched Tree Ensemble Classifier (Random Forest Classifier)	INCR	0.409	HPO-1 FE HPO-2 BATCH	00:01:33
	2	Pipeline 8	Random Forest Classifier		0.409	HPO-1 FE HPO-2	00:01:30
	3	Pipeline 4	Snap Logistic Regression		0.393	HPO-1 FE HPO-2	00:00:24
	4	Pipeline 3	Snap Logistic Regression		0.393	HPO-1 FE	00:00:19

RESULT

This is pipeline comparison matric chart,it shows the performance of all pipelines along with the parameter i.e Accuracy,Log-loss ,etc



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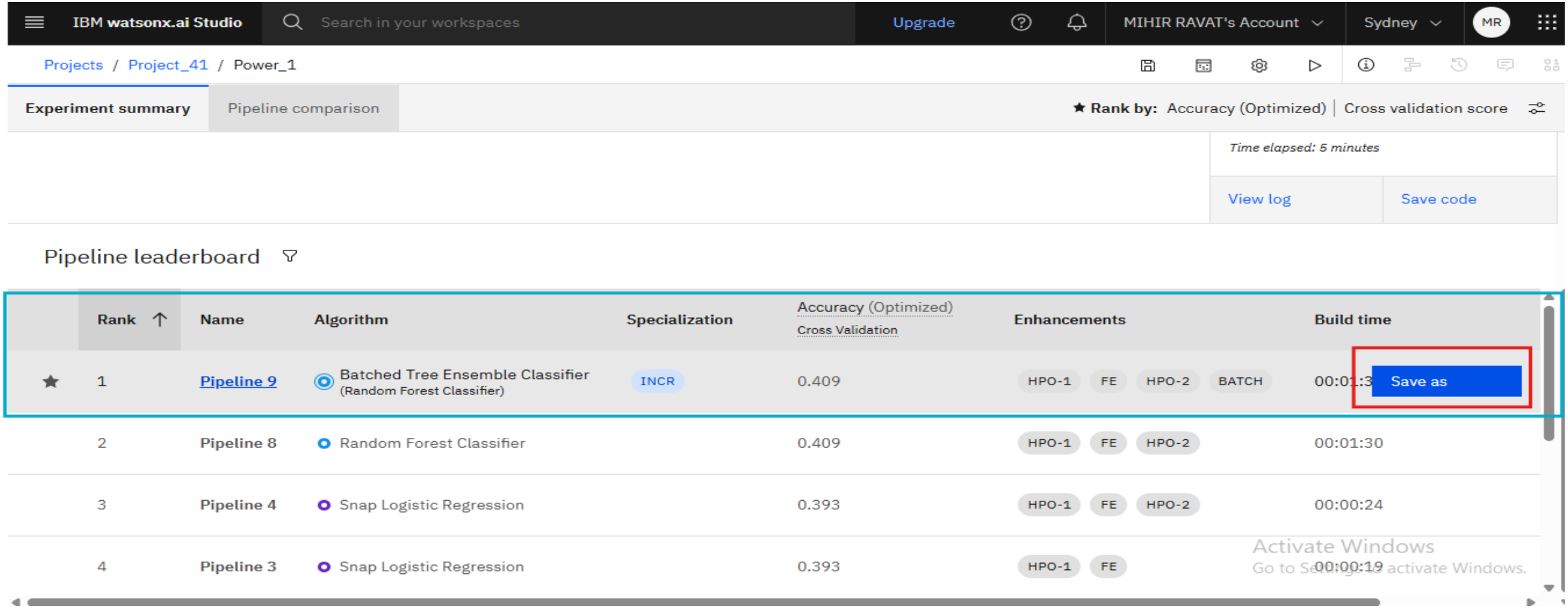
RESULT

Step 20: Select the best pipeline i.e Pipeline9 and click on **save as**



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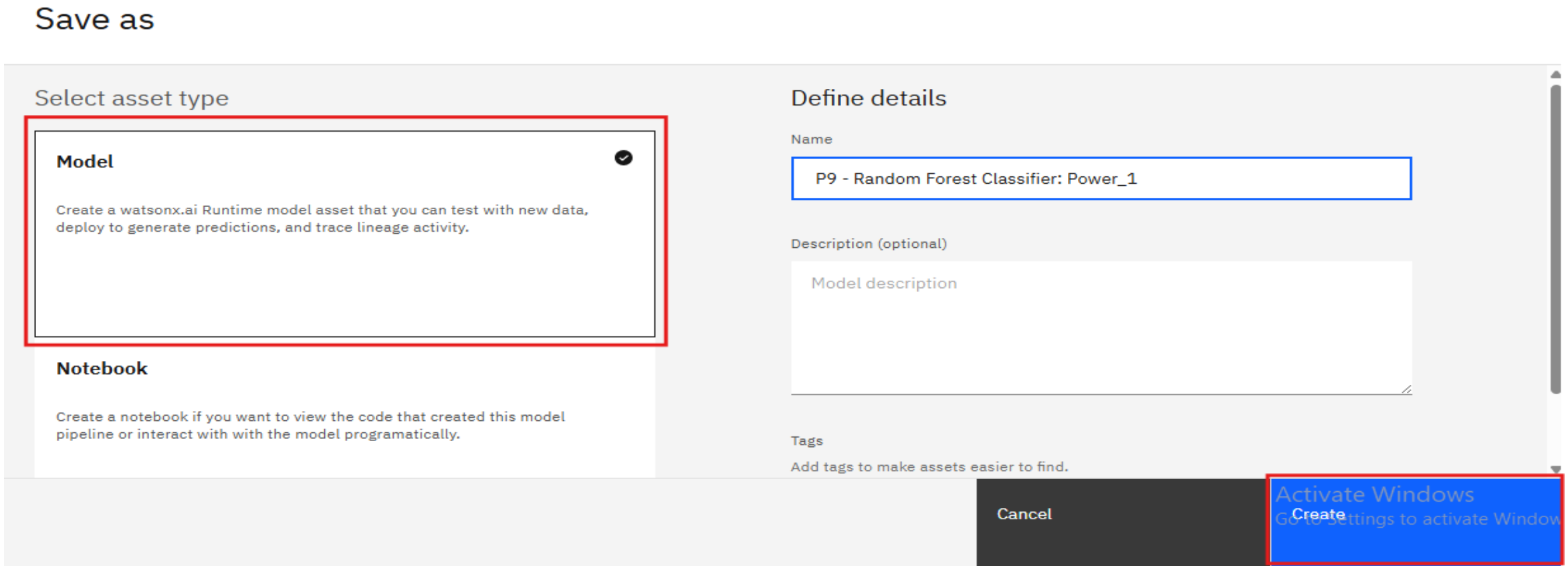
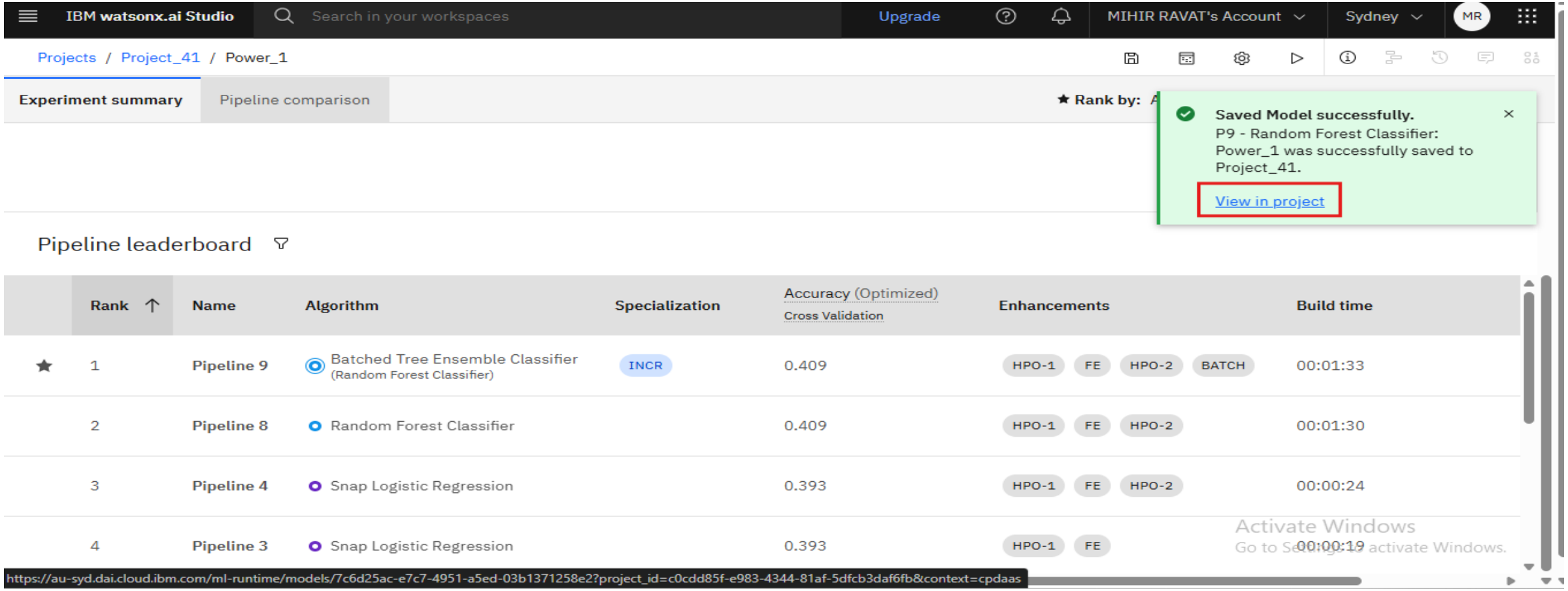
RESULT

Step 21: Choose Model asset and click on Create



RESULT

The mode saved successfully and click on view in project



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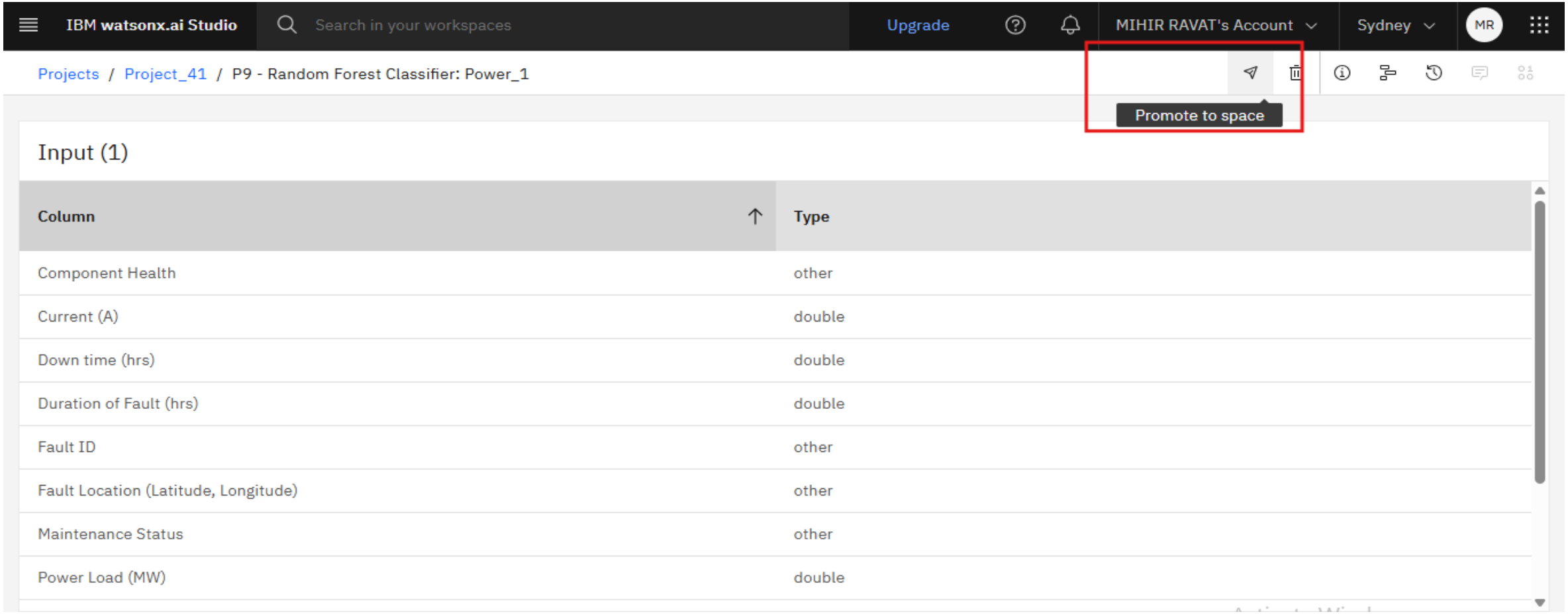
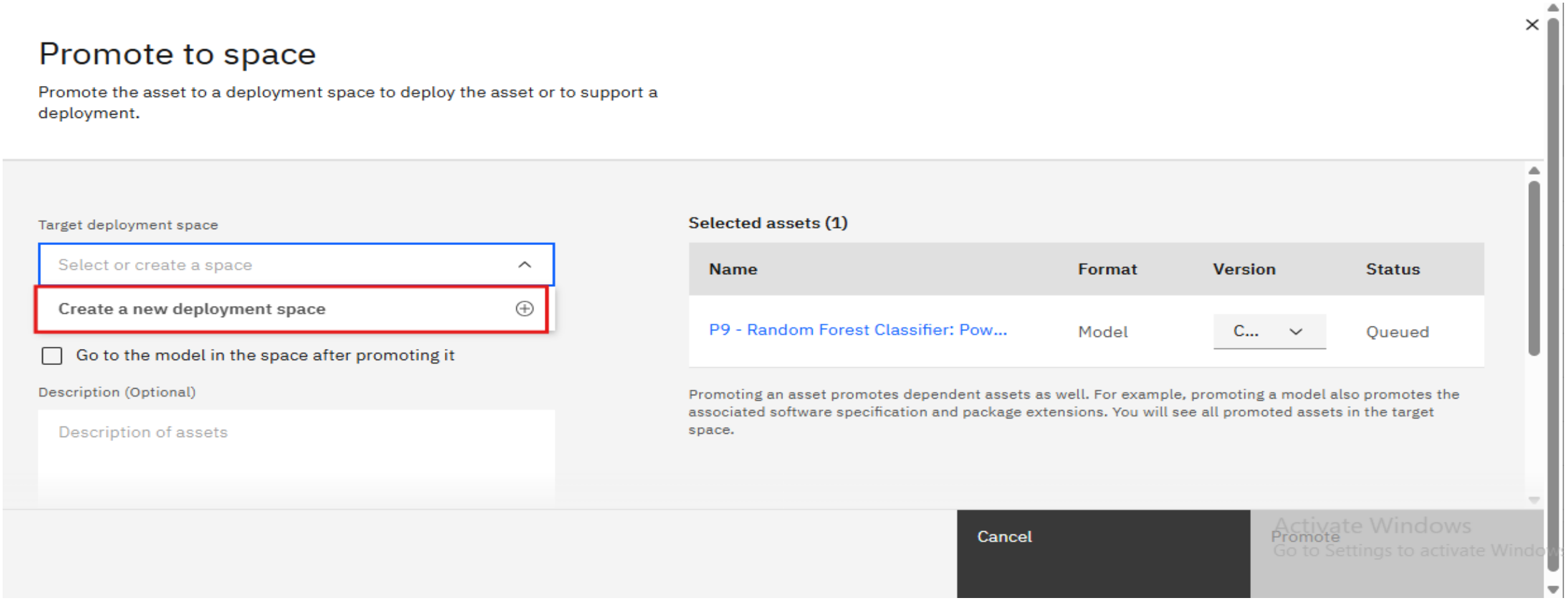
RESULT

Step 22: Click on **promote to space** on arrow



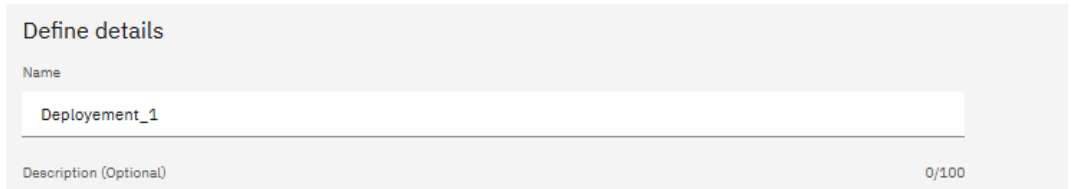
RESULT

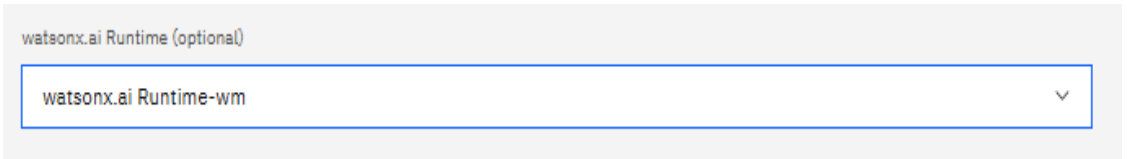
Step 23:Click on **Create a new deployement space**

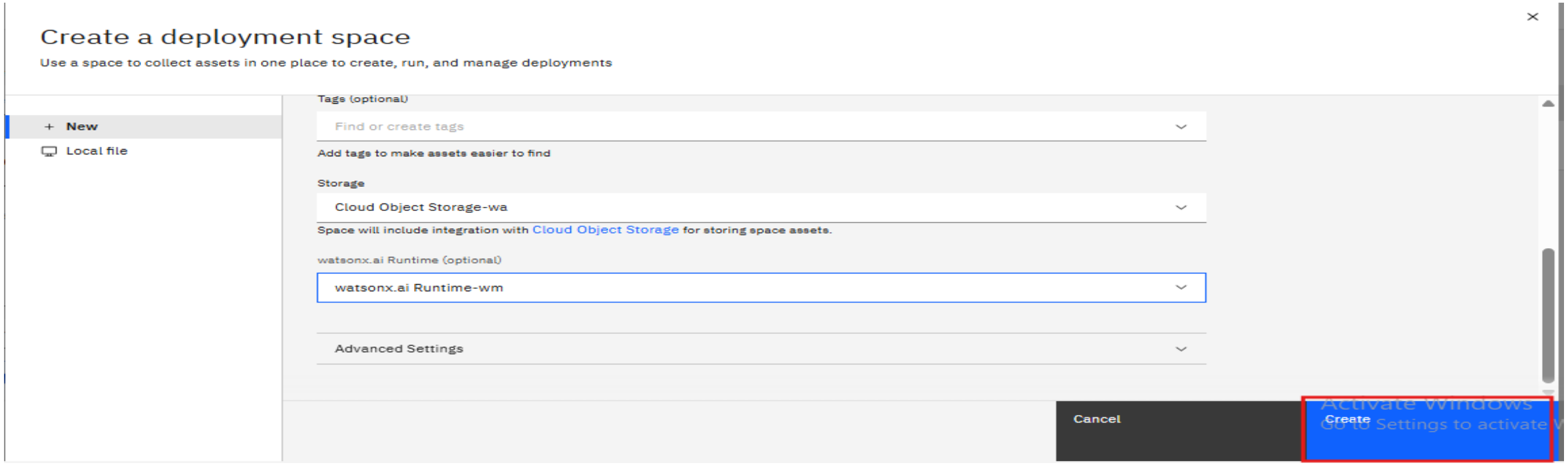


RESULT

Step 24:Give the deployment space name and select **watsonx.ai Runtime service** , click on **Create**

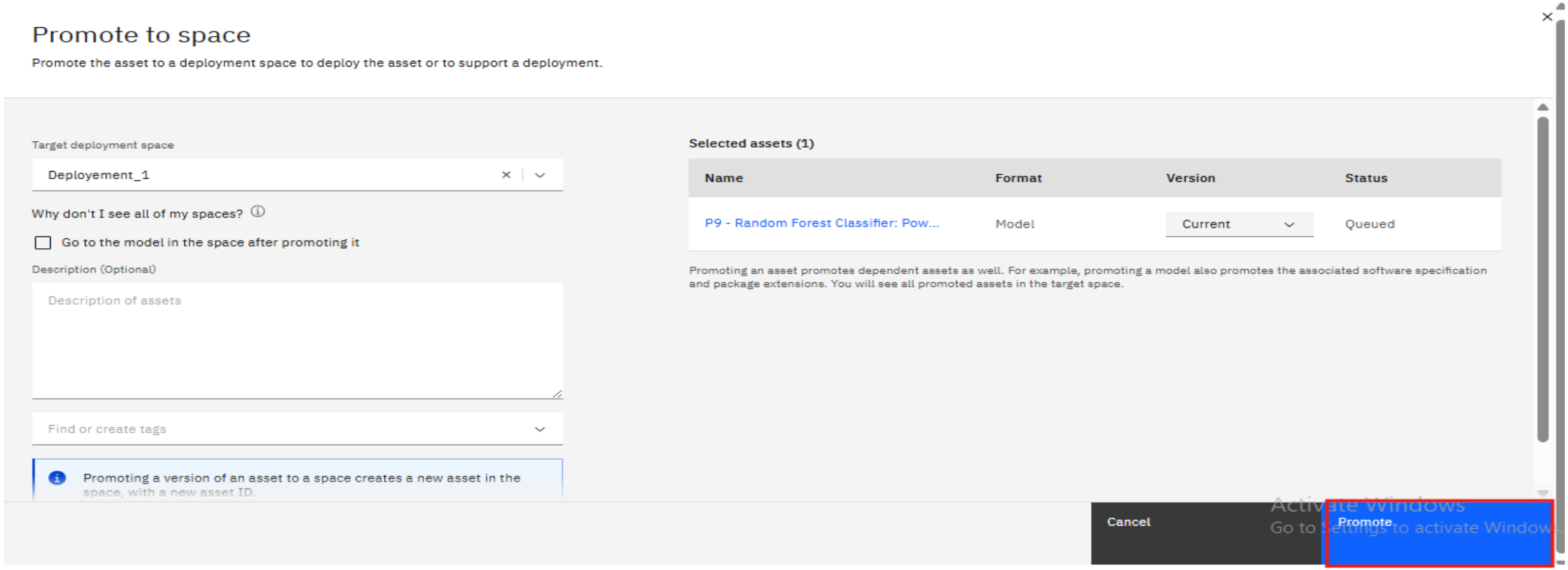






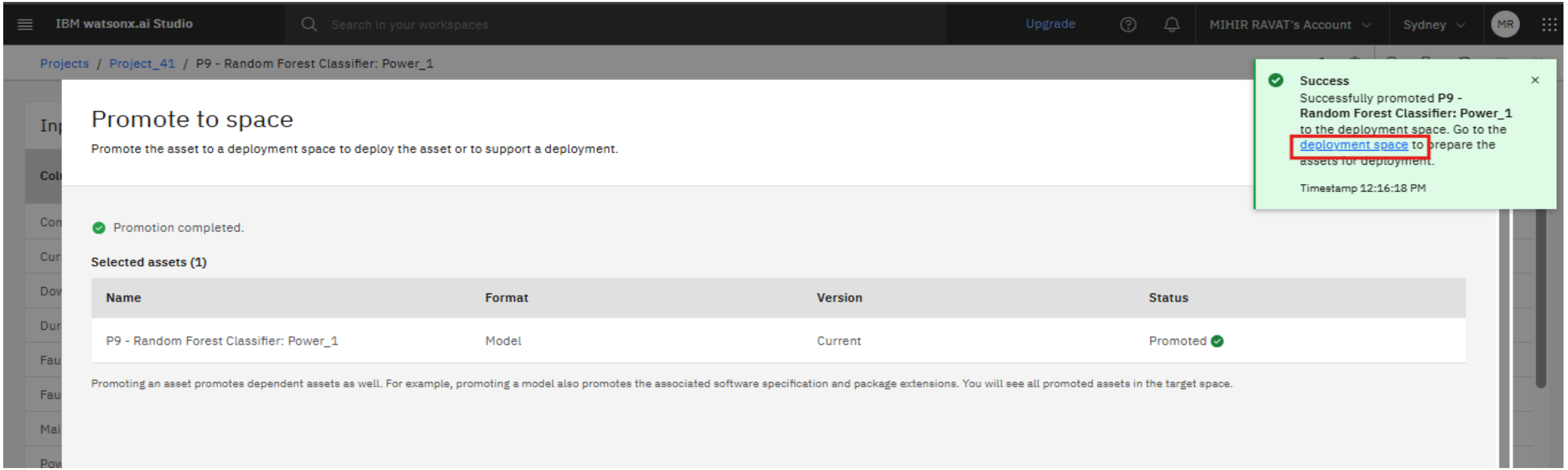
RESULT

Step 25:Click on **Promote**



RESULT

Step 26:It’s Promoted and now click on **deployement space**



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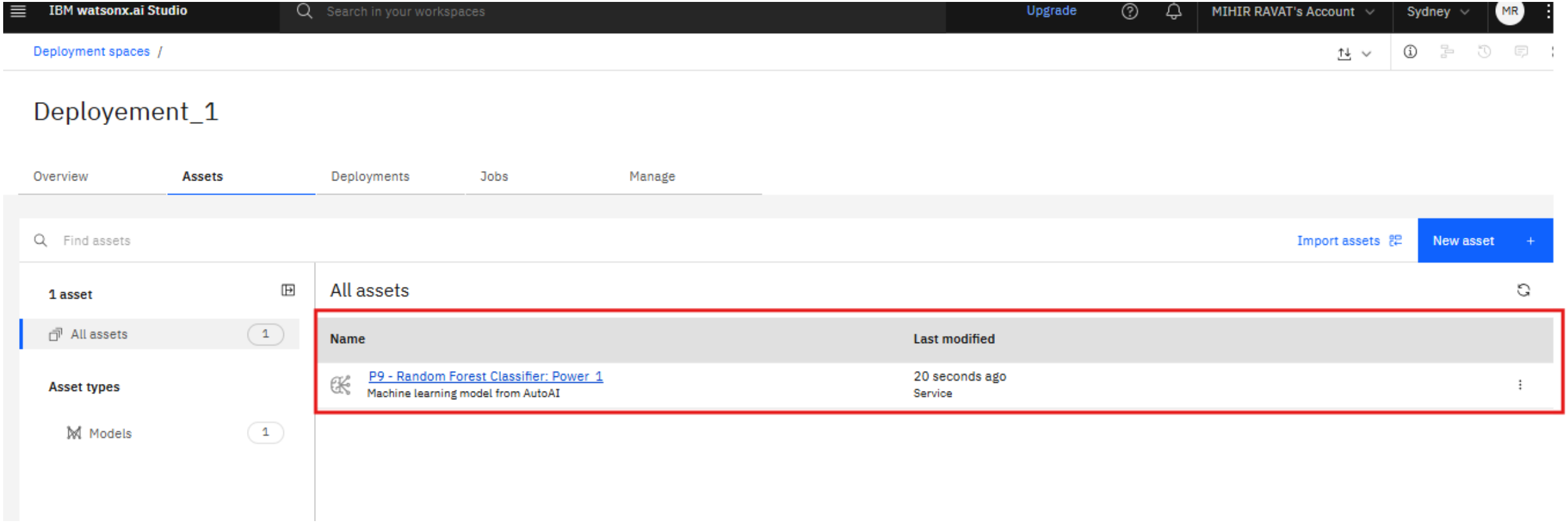
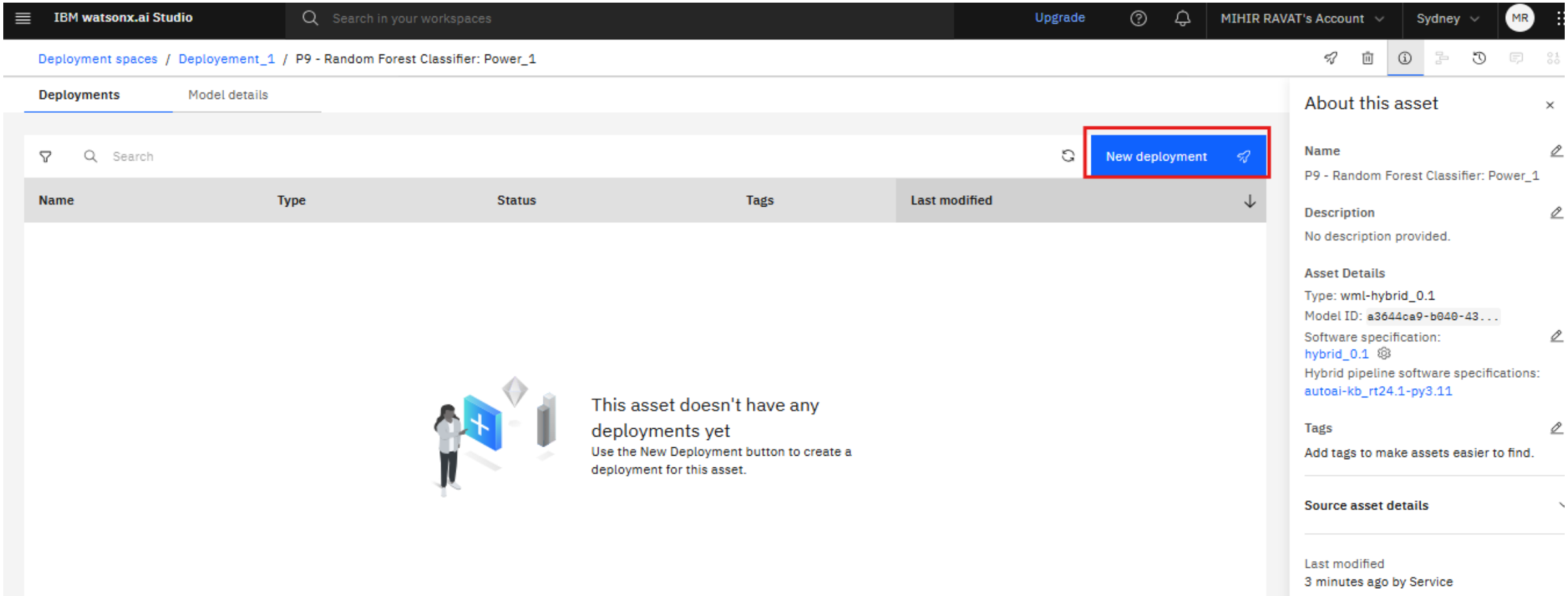
RESULT

Step 27:Click on the Asset name



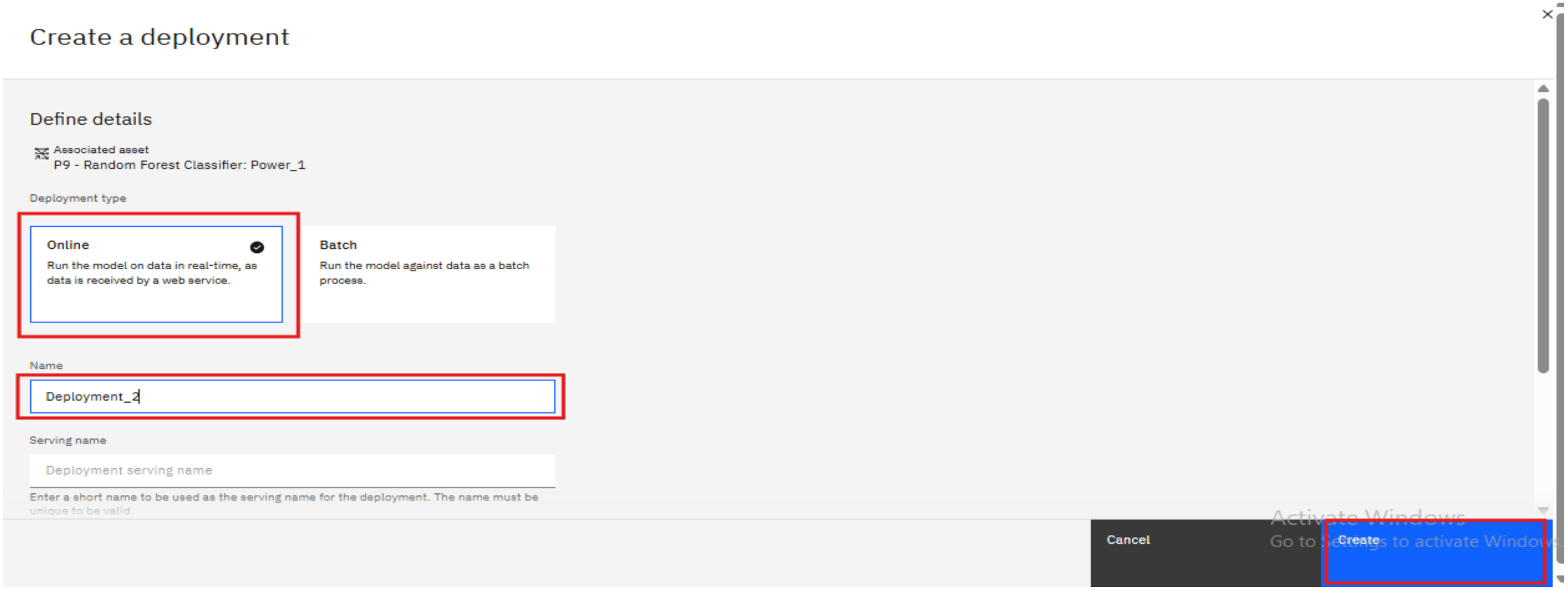
RESULT

Step 28: Click on new deployment



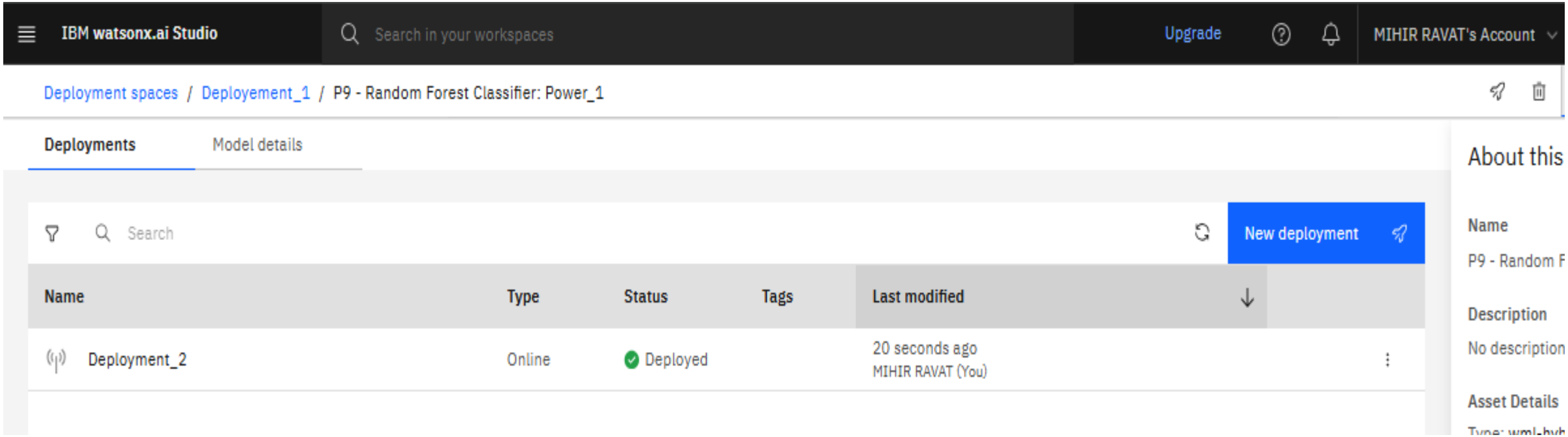
RESULT

Step 29:Select the **deployment type** and **deployement name** and click on **Create**



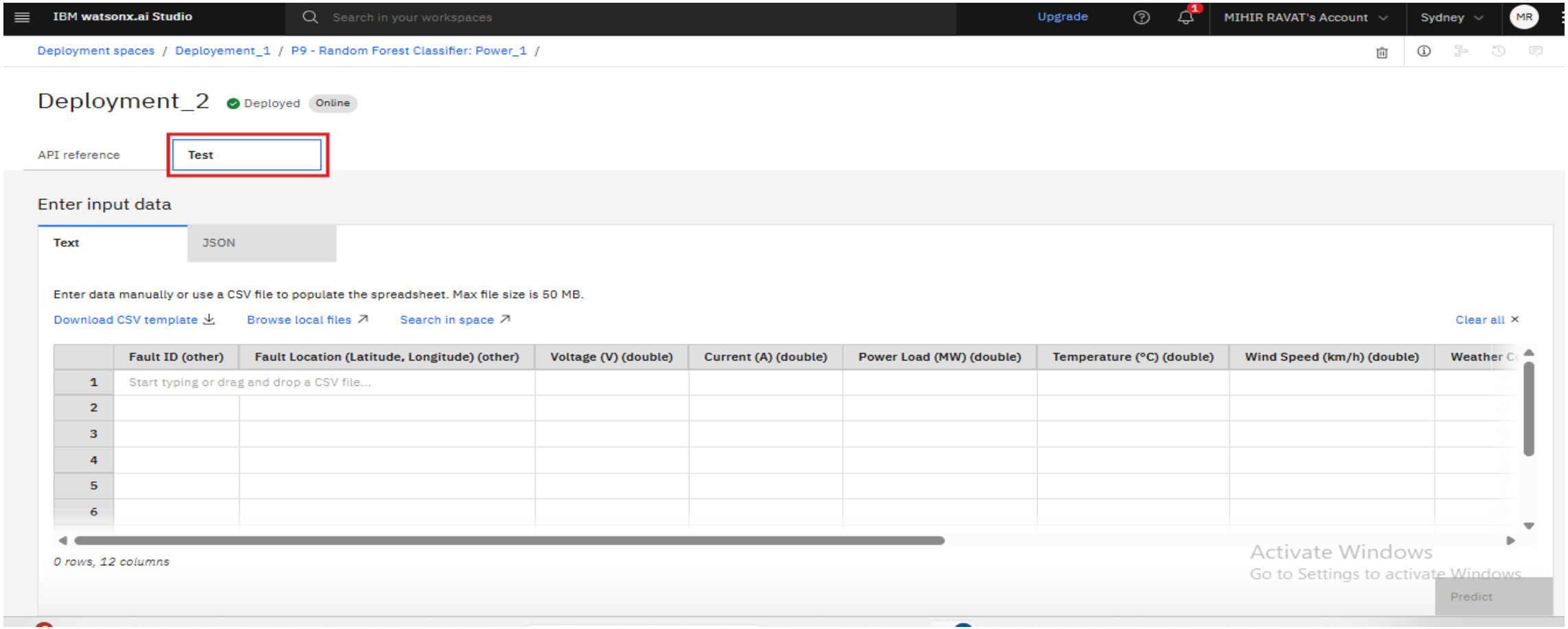
RESULT

The model is deployed



RESULT

Step 30: Now click on Test to predict with new values.Enter the data required from the fault_data.csv and then click on predict



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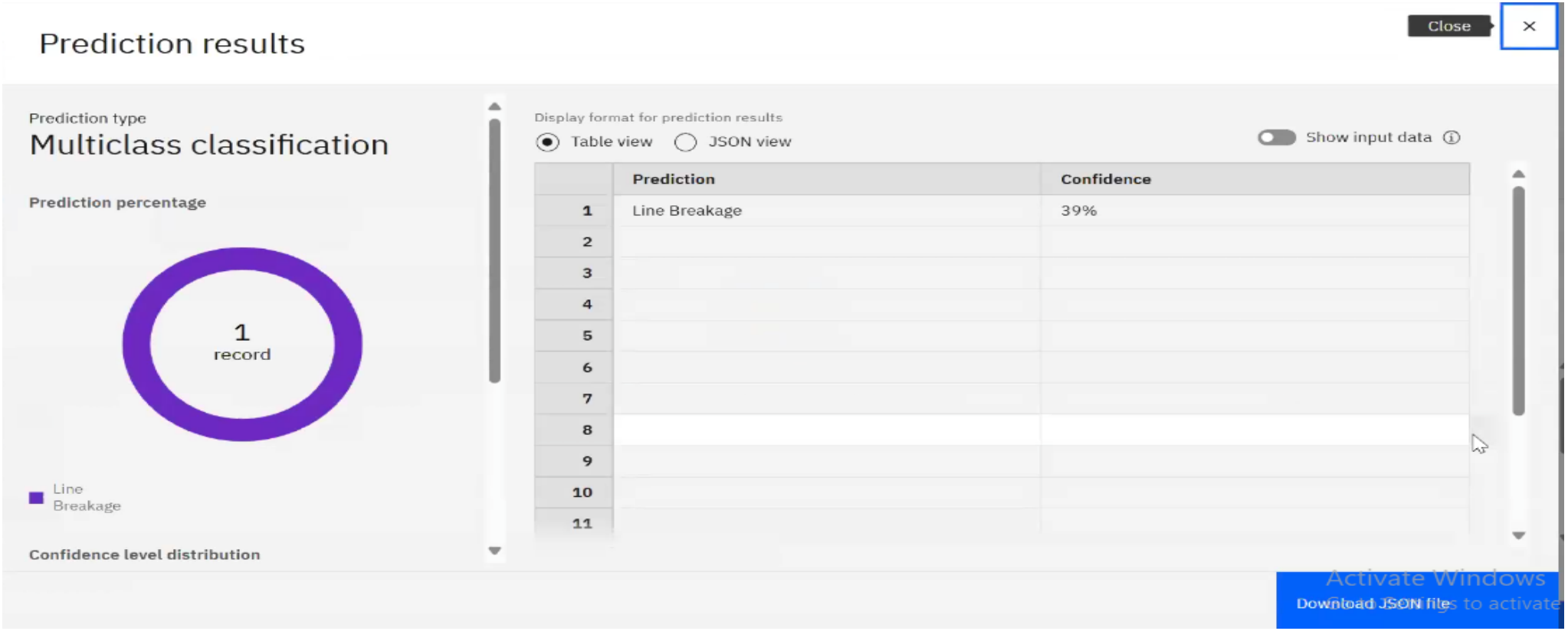
RESULT

The result is being displayed .It shows that the predicition type is **Multiclass classification,**in the table views it shows the confidence for the data entered,here the prediction is **Line Breakage** with a **confidence** of **39%**



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CONCLUSION

- The implementation of a machine learning model for power system fault detection and classification demonstrates the potential of data-driven approaches in improving grid reliability and operational efficiency. By analyzing voltage, current, and phasor measurement data, the model effectively distinguishes between normal and faulty conditions, including line-to-ground, line-to-line, and three-phase faults. Deploying the model on platforms like IBM Watson Studio further enables real-time fault diagnosis and faster system recovery. This work highlights the value of integrating AI with smart grid technologies to enable proactive and intelligent grid management.

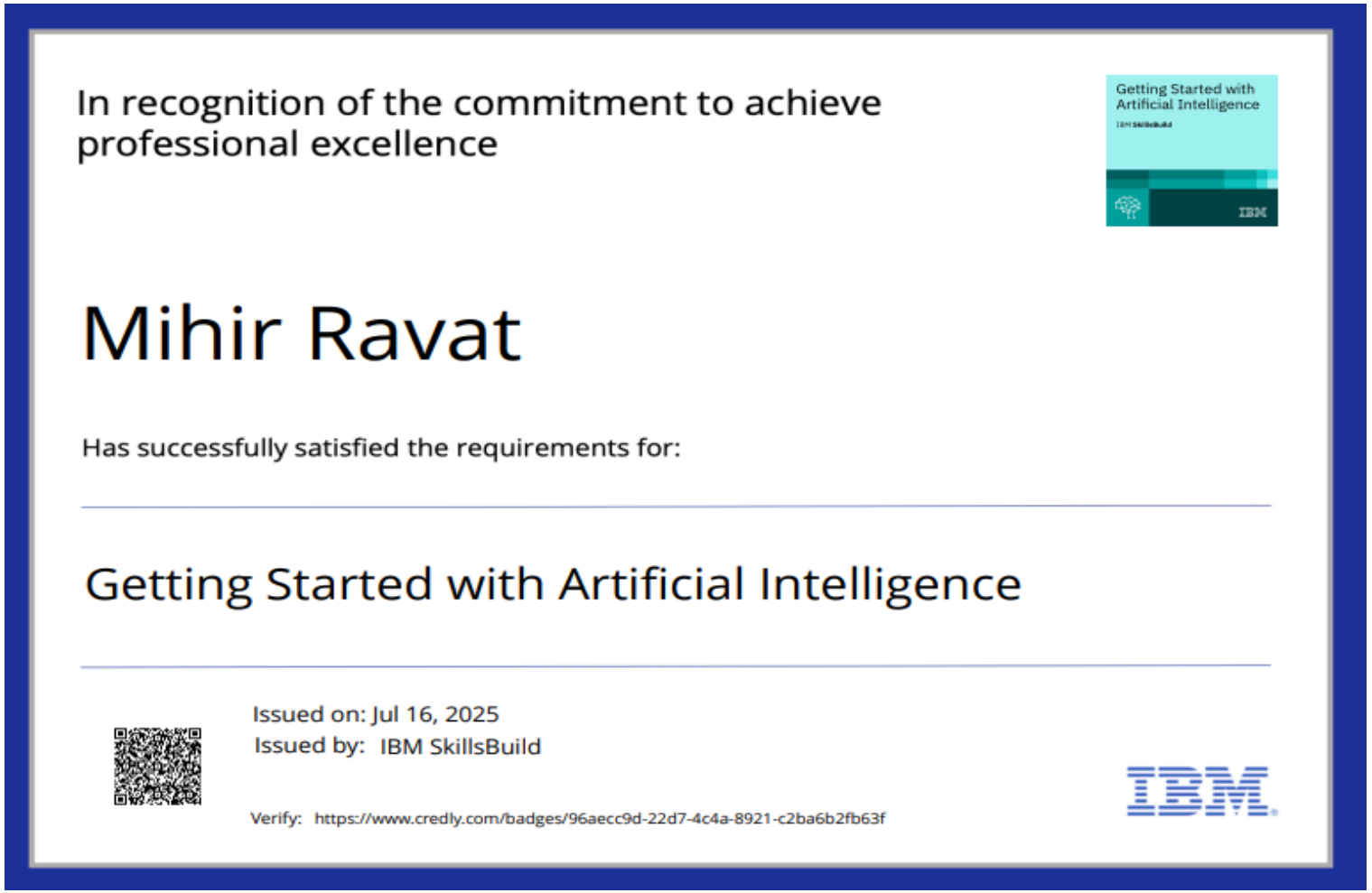
FUTURE SCOPE

- **Model Enhancement**: Explore deep learning techniques (e.g., LSTM or CNN) for improved accuracy in complex fault scenarios.
- **Real-Time Data Integration**: Integrate streaming data from smart sensors or PMUs (Phasor Measurement Units) for live fault monitoring.
- **Scalability**: Extend the system to cover larger grid segments and more diverse fault types.
- **Edge Deployment**: Investigate deployment on edge devices for faster, localized fault detection in remote substations.
- **Cybersecurity Considerations**: Explore secure AI models to prevent tampering and ensure trustworthy grid operation.

REFERENCES

- IBM Cloud Documentation – https://cloud.ibm.com/docs
- Kaggle Dataset: Power System Fault Classification https://www.kaggle.com/datasets/ziya07/power-system-faults-dataset

IBM CERTIFICATIONS



IBM CERTIFICATIONS

In recognition of the commitment to achieve professional excellence

Journey to Cloud: Envisioning Your Solution

IBM

Mihir Ravat

Has successfully satisfied the requirements for:

Journey to Cloud: Envisioning Your Solution

Issued on: Jul 19, 2025
Issued by: IBM SkillsBuild

Verify: https://www.credly.com/badges/ba419b56-d55f-4e53-a90c-7ecb75472e14

IBM

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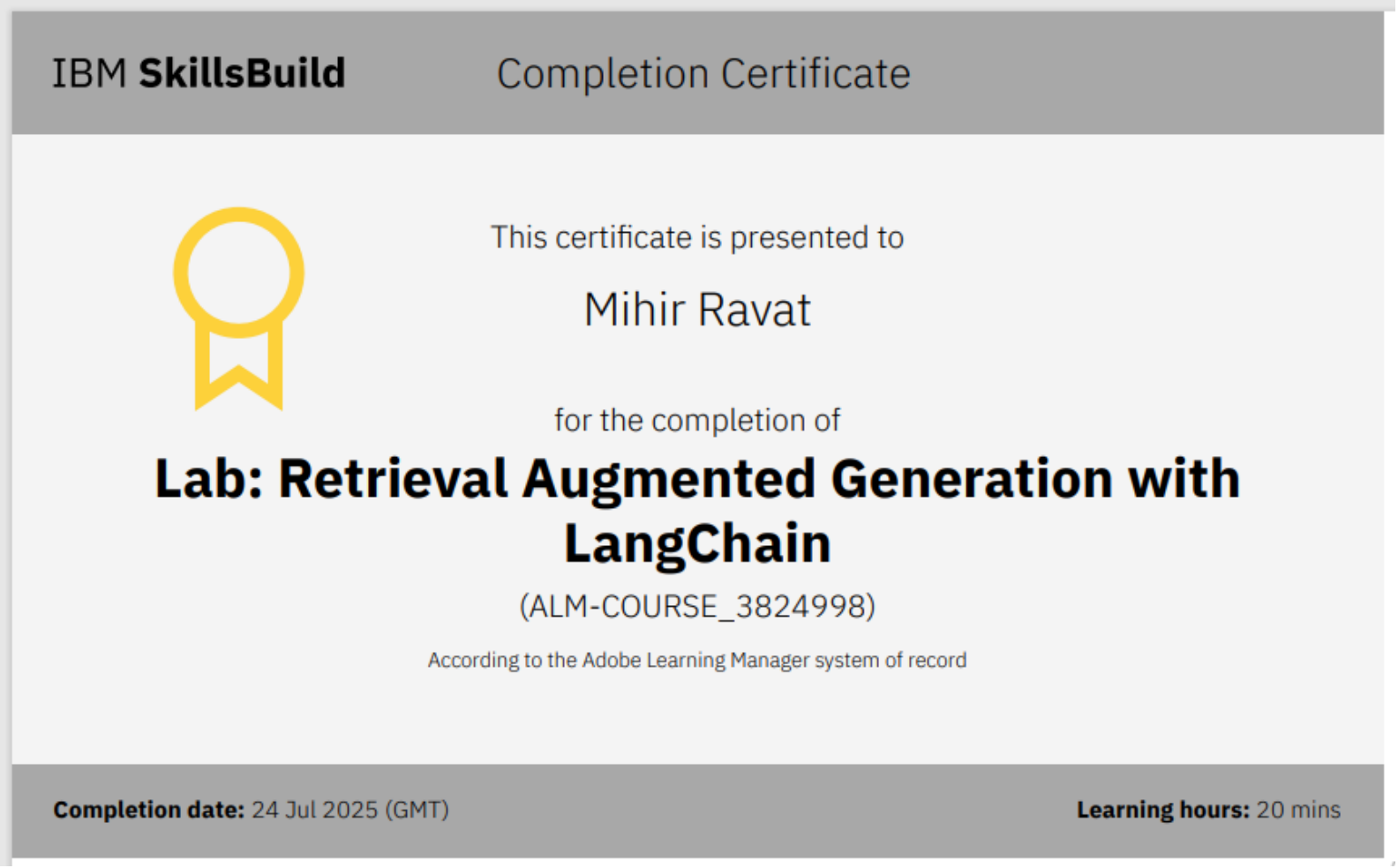

IBM **SkillsBuild** Completion Certificate

This certificate is presented to

Mihir Ravat

for the completion of

Lab: Retrieval Augmented Generation with LangChain

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT) **Learning hours:** 20 mins

THANK YOU

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