IBM PROJECT

- PROJECT TITLE -**Problem statement No.39 – Predictive Maintenance of Industrial Machinery**

- **Presented By:**
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- **College Name- MIT Academy of Engineering.**
- **Department- Computer Engineering.**

OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result (Output Image)
- Conclusion
- Future Scope
- References

PROBLEM STATEMENT

- Industrial machines are prone to unexpected failures such as tool wear, heat dissipation issues, and power failures. These failures cause unplanned downtime, leading to production delays and increased maintenance costs. Traditional maintenance schedules are reactive or time-based, lacking real-time failure prediction capabilities. There is a need to predict failures before they occur using sensor data and machine learning to enable proactive maintenance.

PROPOSED SOLUTION

- **The solution to the problem of unexpected machine failures is a Machine Learning-based predictive maintenance model built and deployed using IBM Watson.ai Studio. Objective of the Solution:-**
- **Goal: Predict machine failure type in advance to enable preventive actions.**
- **Outcome: Reduce unplanned downtime, optimize maintenance schedules, and lower operational costs. Below is the step-by-step explanation**
- **1) Data Collection**: Utilize Kaggle's predictive maintenance dataset containing real sensor data from machines.
- Features include: Air temperature, process temperature , Rotational speed, torque ,Tool wear time , Machine type and quality metrics. This data acts as input for the predictive model.
- **2) Data Preprocessing** : Data cleaning to remove missing and duplicate entries.
- Detect outliers that may affect predictions.
- Normalize features for consistent model training.
- Feature selection to identify variables influencing failures most strongly.

PROPOSED SOLUTION

- **3)Model Development in Watson.ai Studio:** Use Watson.ai Studio's environment for uploading and preparing data.
- Configure AutoAI pipelines to automatically select the best performing algorithm based on the dataset.
- Train the model to classify machine conditions: Tool wear failure ,Heat dissipation failure , Power failure , Normal condition (no failure).
- **4)Deployment on Watson.ai Studio**: Deploy the trained model directly as a web service API from Watson.ai Studio.
- **5)Real-Time Prediction Process**: Live machine sensor data is sent to the deployed Watson.ai Studio API endpoint.
- The model returns a predicted failure category with associated probabilities. Alerts and recommendations are triggered automatically to maintenance teams.
- **6) Benefits of the Solution:** Proactive Maintenance: Early detection of failures using AI predictions.
- Cost Efficiency: Minimized downtime and reduced emergency repair costs.
- Scalable Solution: Can be applied to multiple factories or machine types with minimal adjustments.

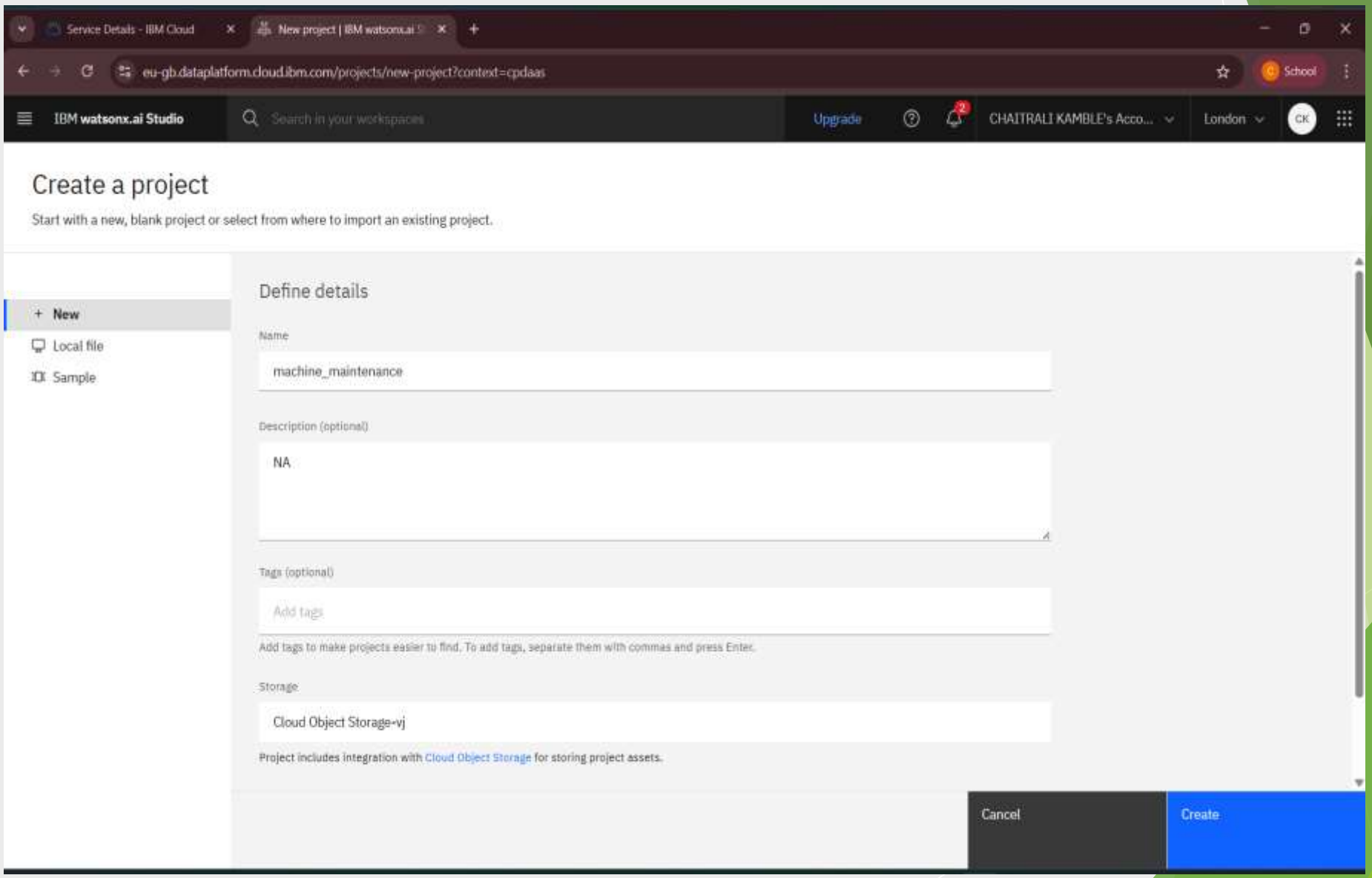
SYSTEM APPROACH

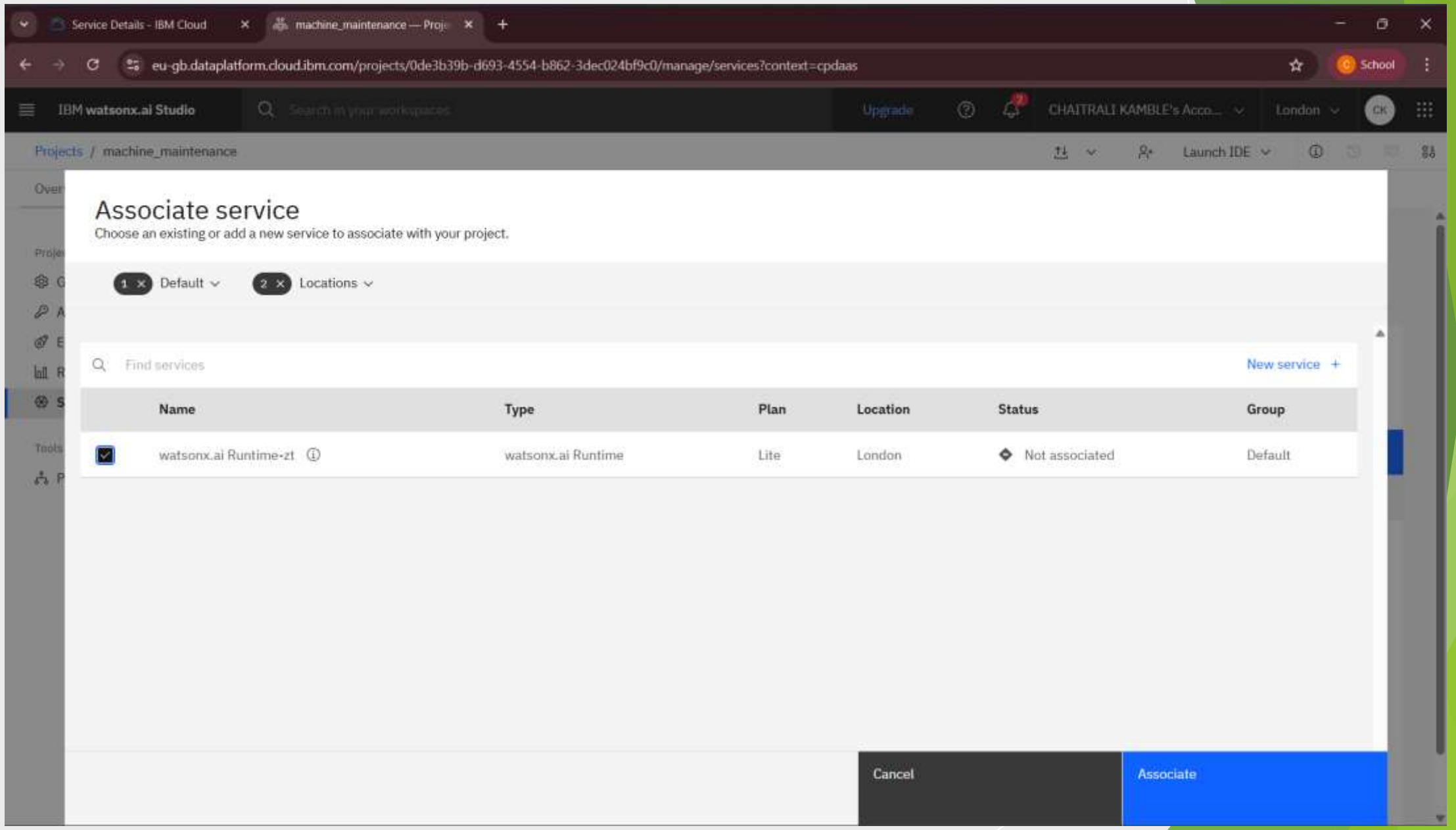
- **The System Approach defines the methodology, resources, and processes followed to develop and deploy the predictive maintenance model.**
- **1)System Requirements:** Software: IBM Watson.ai Studio, Python libraries (Pandas, Scikit-learn, Matplotlib), IBM Watson Machine Learning service.
- Dataset: Kaggle predictive maintenance dataset with sensor readings.
- Cloud Platform: IBM Cloud Lite account for hosting and deployment.
- **2) Data Flow Architecture:** Data Acquisition: Sensor data collected from machines or historical datasets.
- Data Storage: Data uploaded to IBM Cloud Object Storage or Watson.ai Studio environment.
- Data Preprocessing: Cleaning, transformation, and feature engineering of raw data.
- Model Training: AI models developed in Watson.ai Studio using AutoAI.
- Model Deployment: Trained model deployed as a REST API service on IBM Watson Machine Learning.
- Real-Time Prediction: Live data fed to the deployed model, predicting failure types.
- Alert System: Automated notifications sent to maintenance teams for early action.

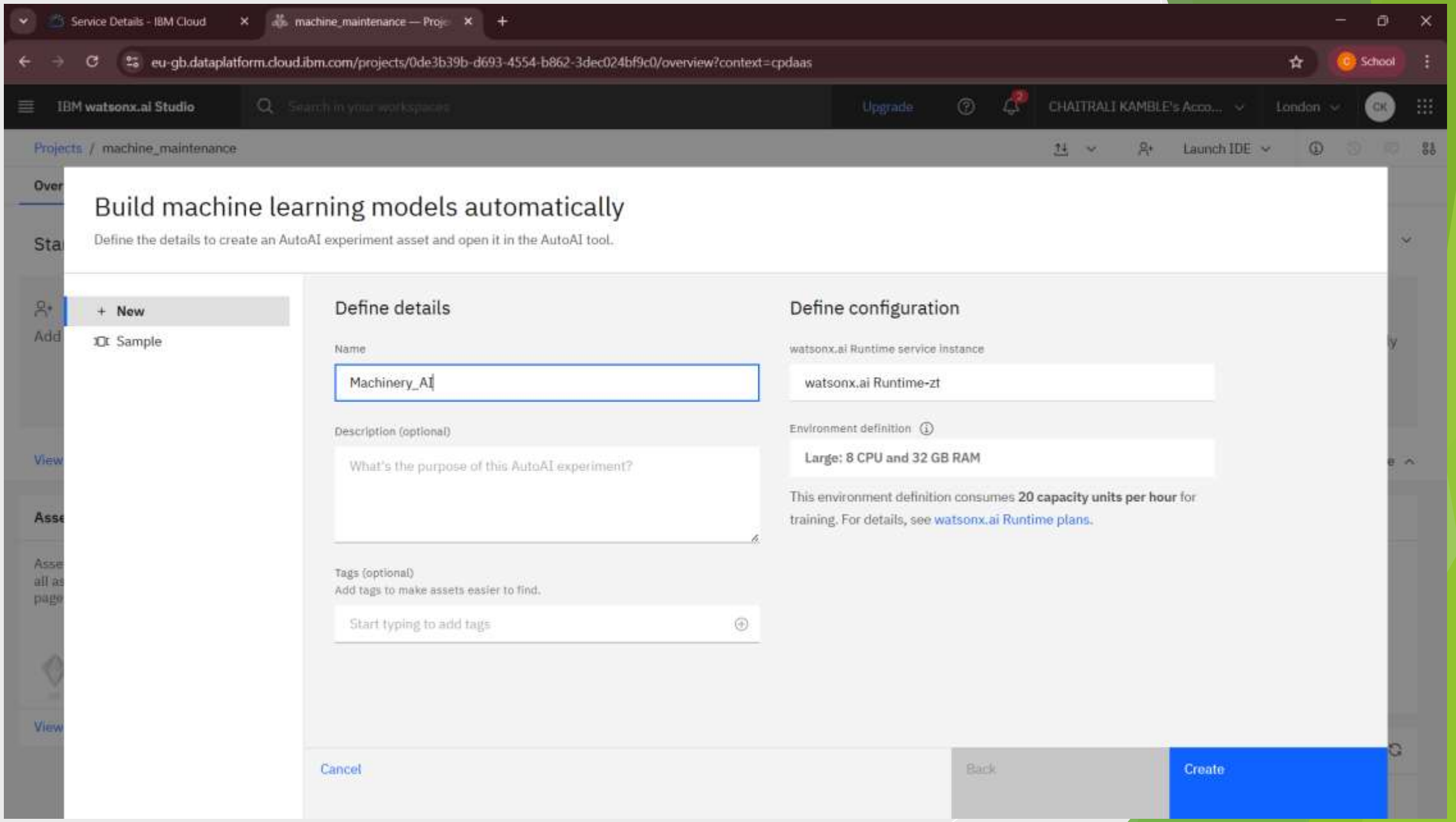
ALGORITHM & DEPLOYMENT

- **Algorithm and deployment framework ensures a robust, scalable, and automated predictive maintenance system that can efficiently prevent unexpected machinery failures.**
- **Algorithm Selection**: Random Forest Classifier for multi-class classification of failure types.
- Input Features: Air temperature, process temperature, rotational speed, torque, tool wear time, and quality measures.
- Training: Model trained on historical failure data, optimizing accuracy and precision.
- Prediction: Real-time sensor data fed into the model to predict failure type.
- **Deployment:** Model deployed on IBM Watson Machine Learning service, accessible via API for integration into factory systems.

RESULT


Service Details - IBM Cloud
New project | IBM watsonx.ai
eu-gb.dataplatform.cloud.ibm.com/projects/new-project?context=cpdaas
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acco...
London
CK
Create a project
Start with a new, blank project or select from where to import an existing project.
New
Local file
Sample
Define details
Name
machine_maintenance
Description (optional)
NA
Tags (optional)
Add tags
Add tags to make projects easier to find. To add tags, separate them with commas and press Enter.
Storage
Cloud Object Storage-vj
Project includes integration with Cloud Object Storage for storing project assets.
Cancel
Create


Service Details - IBM Cloud
machine_maintenance — Proje
eu-gb.dataplatform.cloud.ibm.com/projects/0de3b39b-d693-4554-b862-3dec024bf9c0/manage/services?context=cpdaas
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acco...
London
CK
Projects / machine_maintenance
Launch IDE
Associate service
Choose an existing or add a new service to associate with your project.
1 Default
2 Locations
Find services
New service +
Name
Type
Plan
Location
Status
Group
watsonx.ai Runtime-zt
watsonx.ai Runtime
Lite
London
Not associated
Default
Cancel
Associate


Service Details - IBM Cloud
machine_maintenance — Proje
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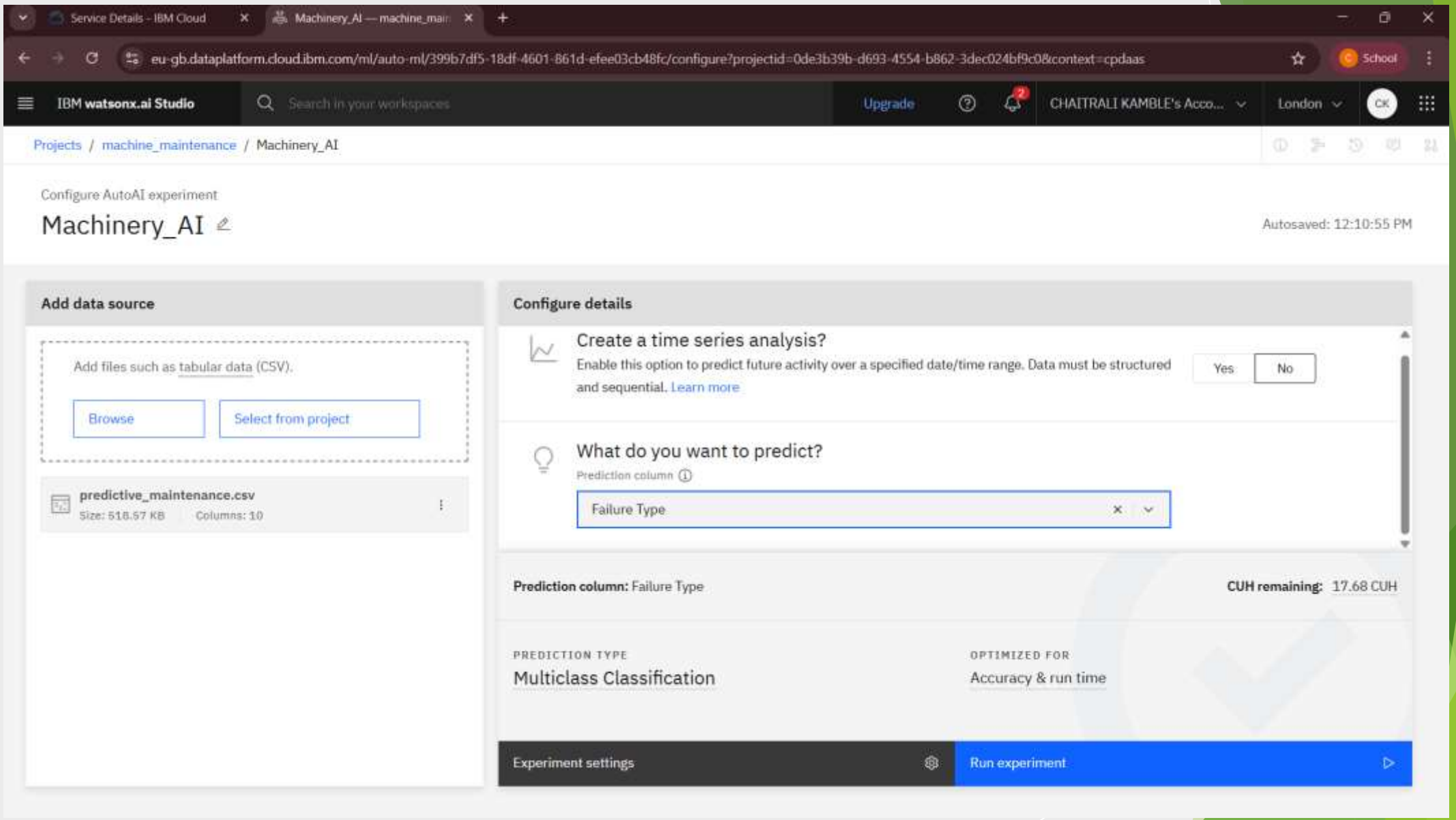
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acco...
London
CK
Projects / machine_maintenance
Launch IDE
Build machine learning models automatically
Define the details to create an AutoAI experiment asset and open it in the AutoAI tool.
+ New
Sample
Define details
Name
Machinery_AI
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
Define configuration
watsonx.ai Runtime service instance
watsonx.ai Runtime-zt
Environment definition
Large: 8 CPU and 32 GB RAM
This environment definition consumes 20 capacity units per hour for training. For details, see watsonx.ai Runtime plans.
Cancel
Back
Create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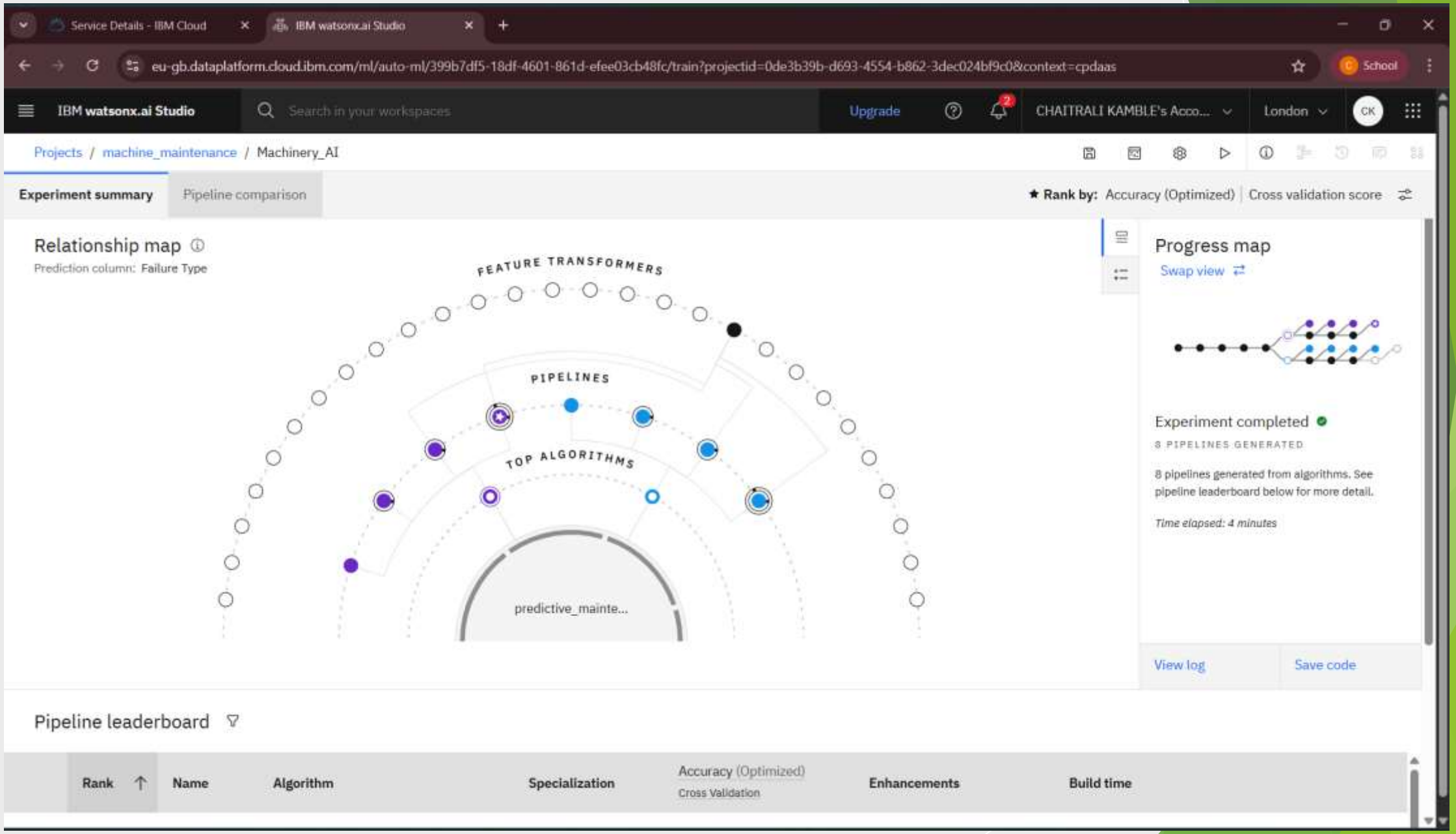
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acco...
London
CK
Projects / machine_maintenance / Machinery_AI
Configure AutoAI experiment
Machinery_AI
Autosaved: 12:10:55 PM
Add data source
Add files such as tabular data (CSV).
Browse
Select from project
predictive_maintenance.csv
Size: 516.57 KB
Columns: 10
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
What do you want to predict?
Prediction column
Failure Type
Prediction column: Failure Type
CUH remaining: 17.68 CUH
PREDICTION TYPE
Multiclass Classification
OPTIMIZED FOR
Accuracy & run time
Experiment settings
Run experiment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IBM watsonx.ai Studio
Search in your workspaces
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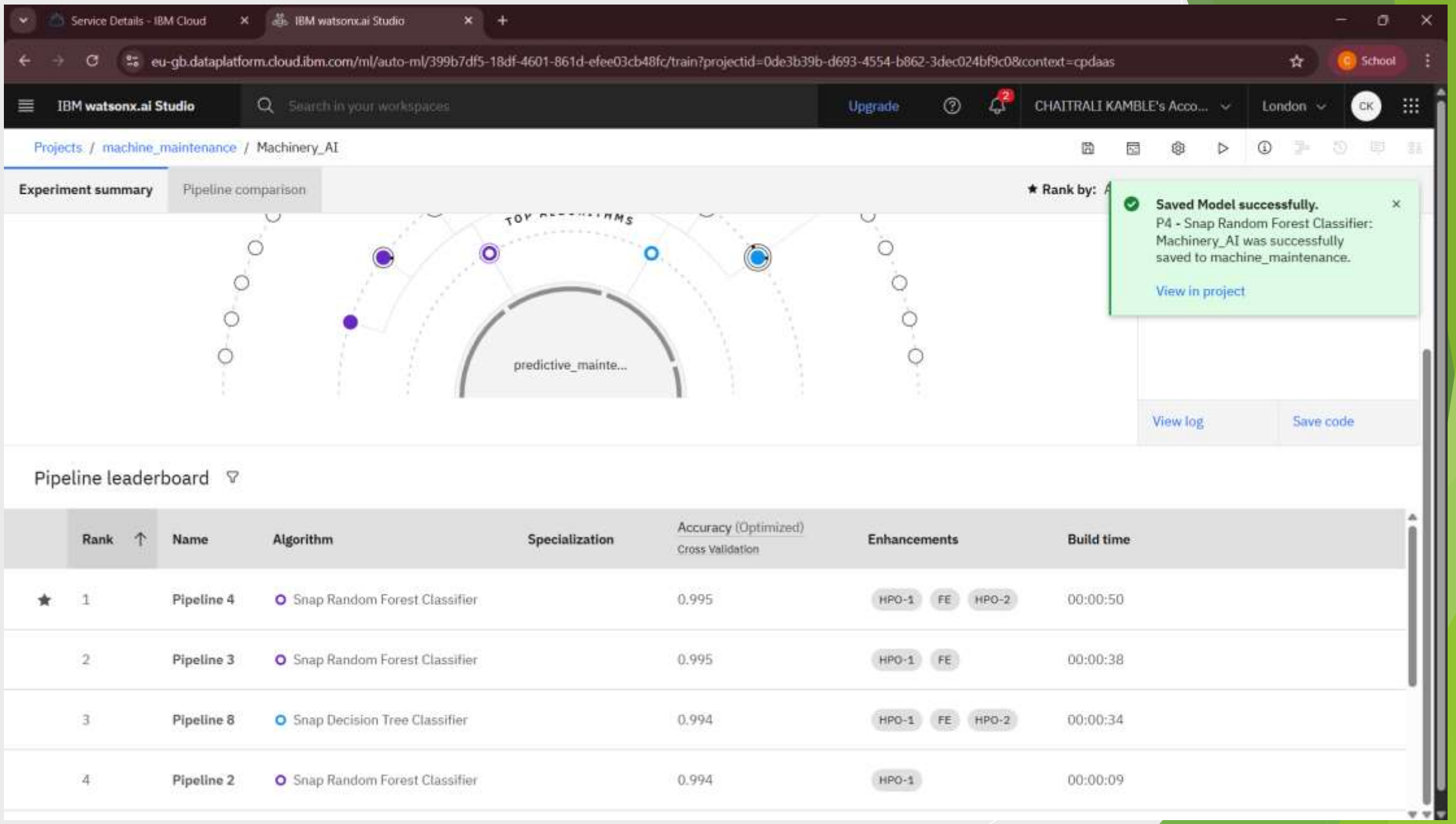
Projects / machine_maintenance / Machinery_AI
Experiment summary
Pipeline comparison
Rank by: Accuracy (Optimized)
Cross validation score
Relationship map
Prediction column: Failure Type
FEATURE TRANSFORMERS
PIPELINES
TOP ALGORITHMS
predictive_mainte...
Progress map
Swap view
Experiment completed
8 PIPELINES GENERATED
8 pipelines generated from algorithms. See pipeline leaderboard below for more detail.
Time elapsed: 4 minutes
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Cross Validation
Enhancements
Build time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IBM watsonx.ai Studio
eu-gb.dataplatform.cloud.ibm.com/ml/auto-ml/399b7df5-18df-4601-861d-efee03cb48fc/train?projectid=0de3b39b-d693-4554-b862-3dec024bf9c0&context=cpdaas
IBM watsonx.ai Studio
Search in your workspaces
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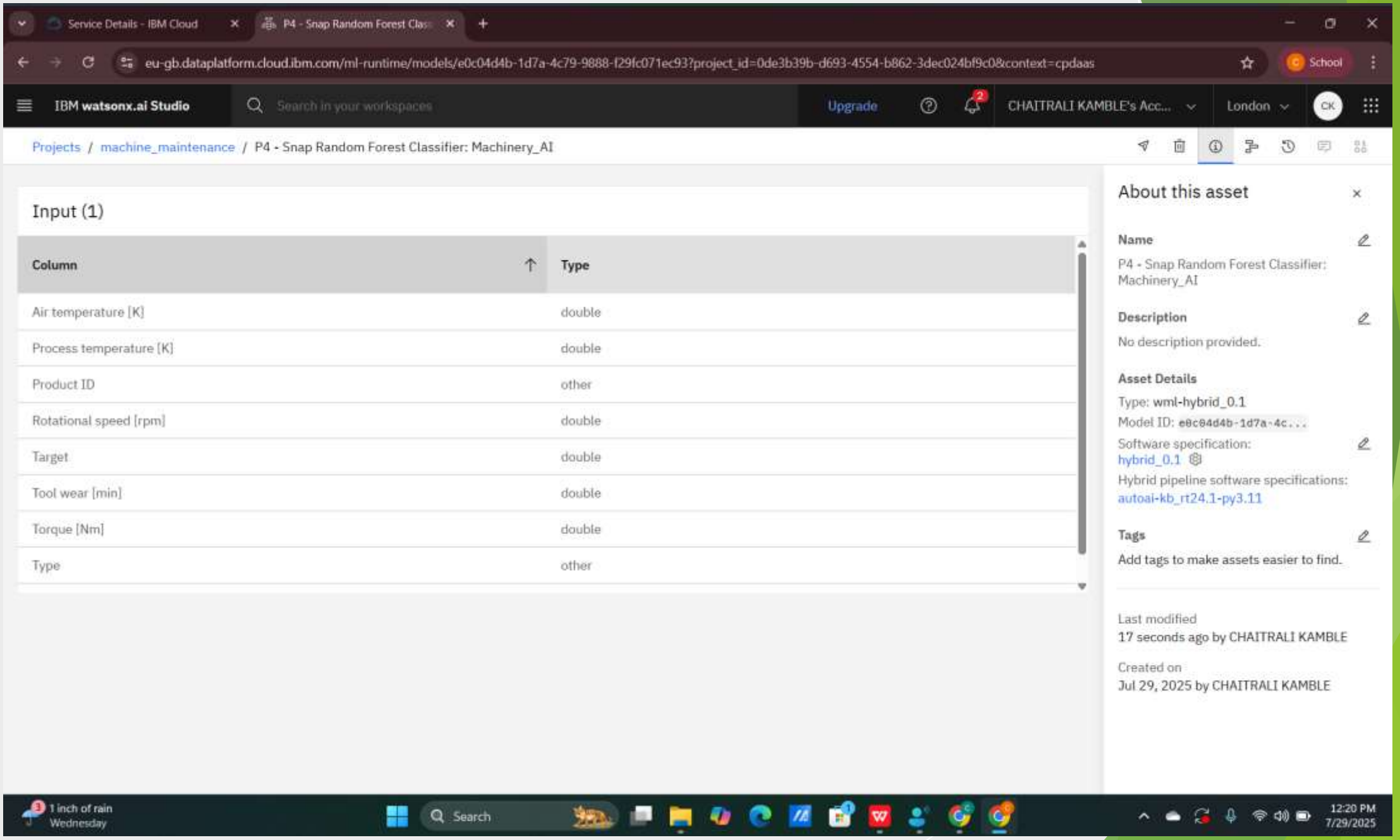
CHAITRALI KAMBLE's Acco...
London
Projects / machine_maintenance / Machinery_AI
Experiment summary
Pipeline comparison
Rank by:
Saved Model successfully.
P4 - Snap Random Forest Classifier: Machinery_AI was successfully saved to machine_maintenance.
View in project
predictive_mainte...
View log
Save code
Pipeline leaderboard
Rank
Name
Algorithm
Specialization
Accuracy (Optimized)
Cross Validation
Enhancements
Build time
1 Pipeline 4 Snap Random Forest Classifier 0.995 HPO-1 FE HPO-2 00:00:50
2 Pipeline 3 Snap Random Forest Classifier 0.995 HPO-1 FE 00:00:38
3 Pipeline 8 Snap Decision Tree Classifier 0.994 HPO-1 FE HPO-2 00:00:34
4 Pipeline 2 Snap Random Forest Classifier 0.994 HPO-1 00:00:09


Service Details - IBM Cloud
P4 - Snap Random Forest Clas
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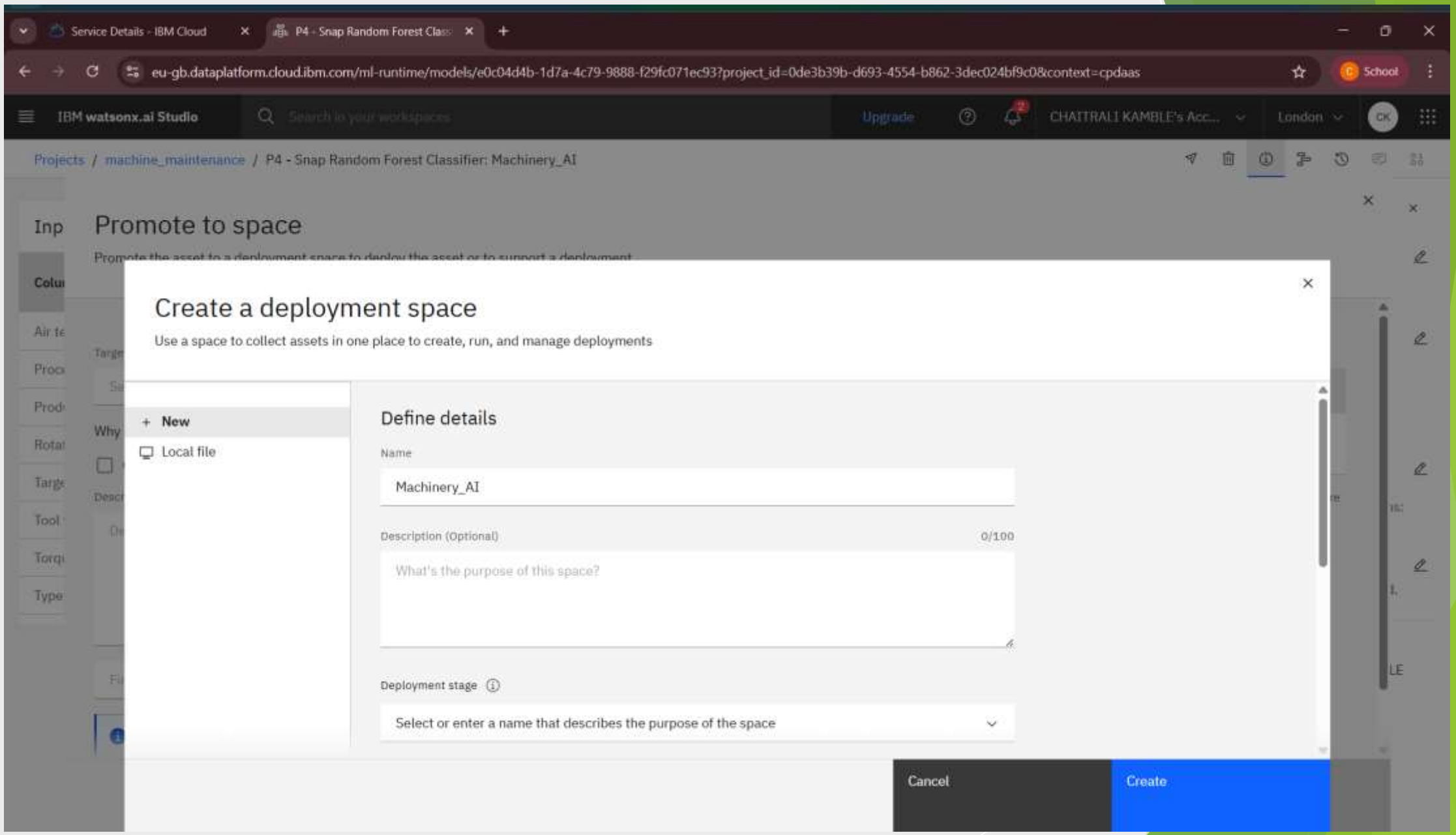
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acc...
London
CK
Projects / machine_maintenance / P4 - Snap Random Forest Classifier: Machinery_AI
Input (1)
Column
Type
Air temperature [K] double
Process temperature [K] double
Product ID other
Rotational speed [rpm] double
Target double
Tool wear [min] double
Torque [Nm] double
Type other
About this asset
Name
P4 - Snap Random Forest Classifier: Machinery_AI
Description
No description provided.
Asset Details
Type: wml-hybrid_0.1
Model ID: e0c04d4b-1d7a-4c...
Software specification: hybrid_0.1
Hybrid pipeline software specifications: autoai-kb_rt24.1-py3.11
Tags
Add tags to make assets easier to find.
Last modified
17 seconds ago by CHAITRALI KAMBLE
Created on
Jul 29, 2025 by CHAITRALI KAMBLE
1 inch of rain
Wednesday
Search
12:20 PM
7/29/2025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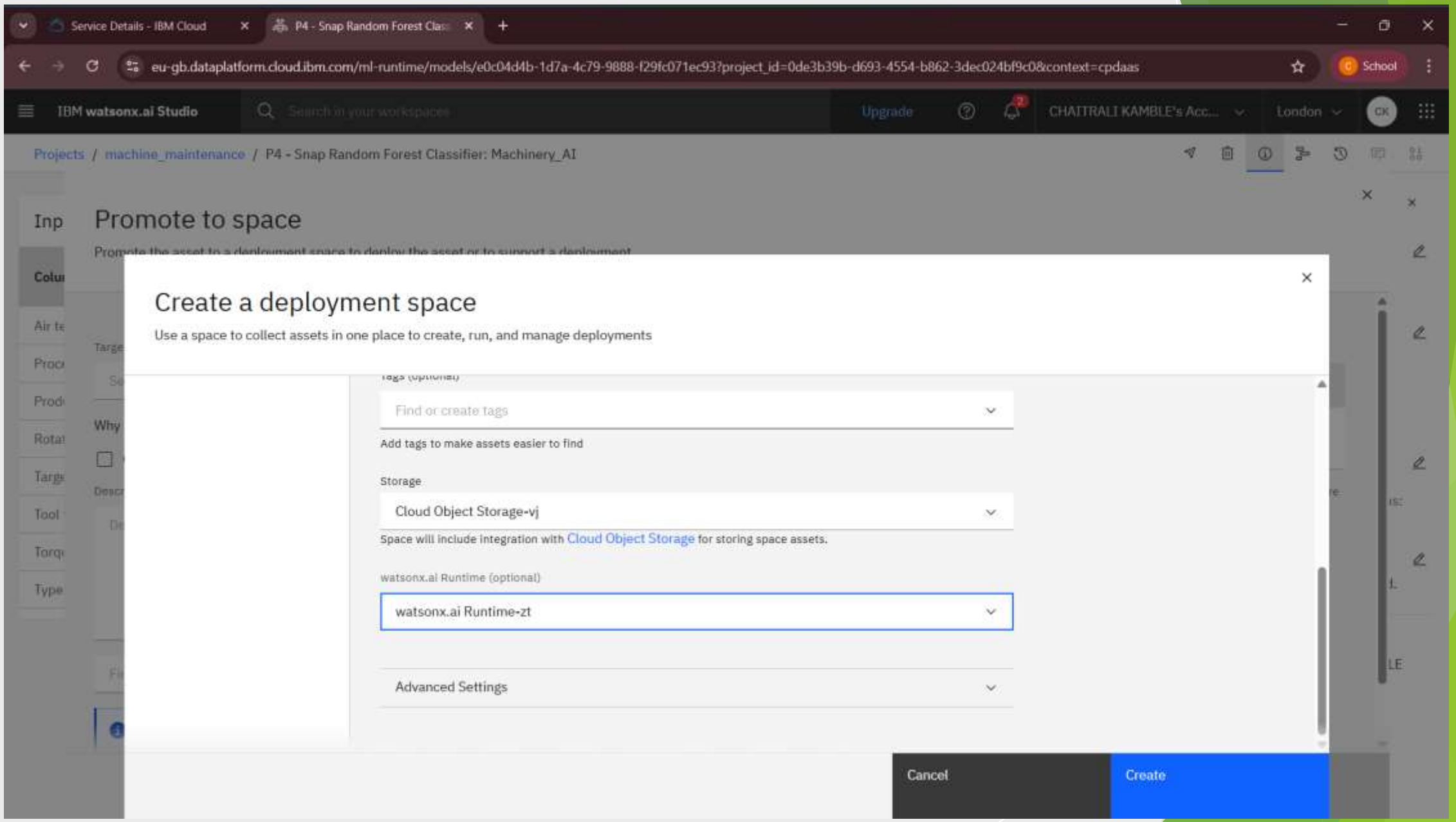
IBM watsonx.ai Studio
Upgrade
CHAITRALI KAMBLE's Acc...
London
Projects / machine_maintenance / P4 - Snap Random Forest Classifier: Machinery_AI
Promote to space
Create a deployment space
Use a space to collect assets in one place to create, run, and manage deployments
New
Local file
Define details
Name
Machinery_AI
Description (Optional)
0/100
What's the purpose of this space?
Deployment stage
Select or enter a name that describes the purpose of the space
Cancel
Create


Service Details - IBM Cloud
P4 - Snap Random Forest Clas
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School
IBM watsonx.ai Studio
Search in your workspaces
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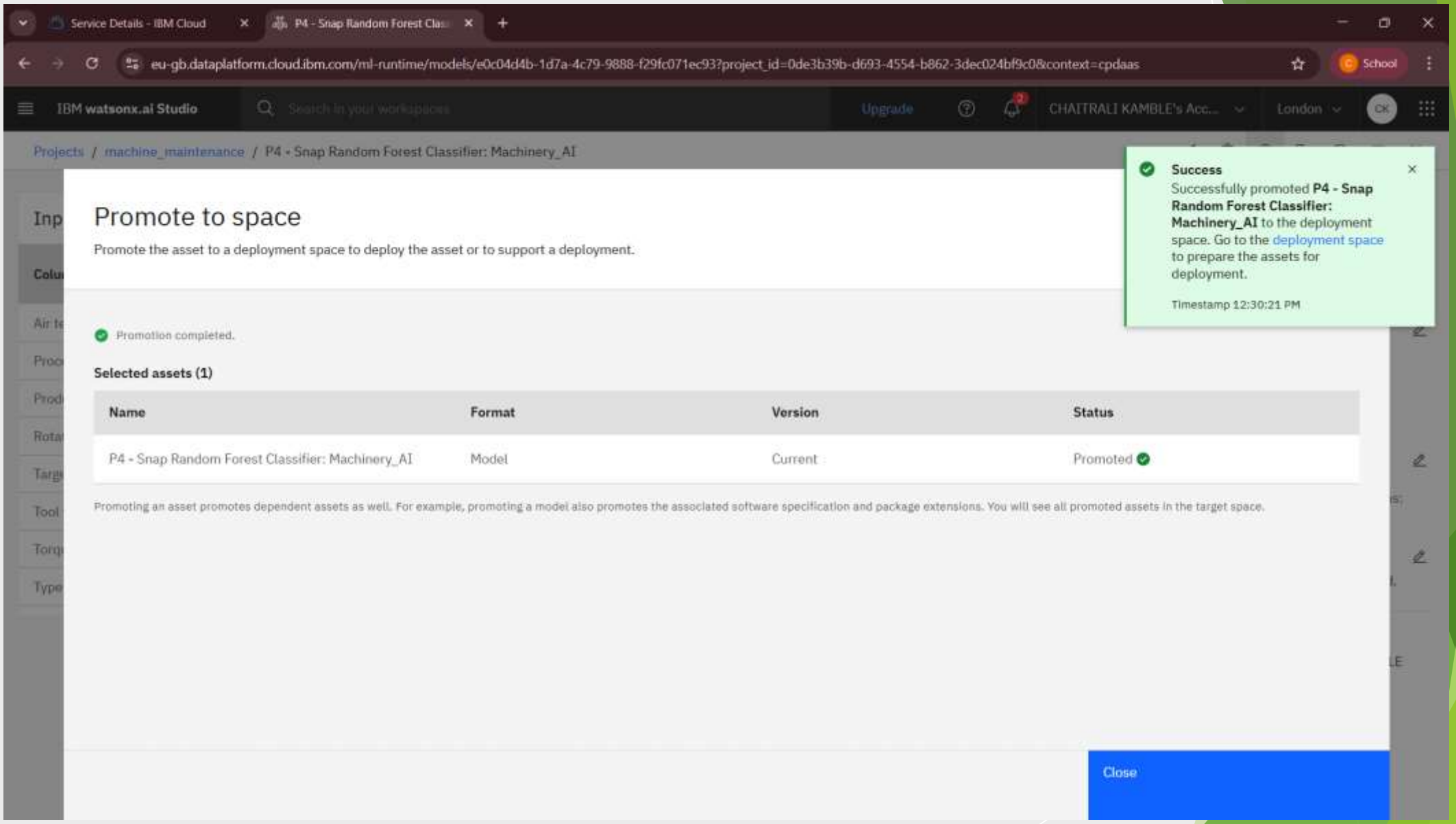
London
CK
Projects / machine_maintenance / P4 - Snap Random Forest Classifier: Machinery_AI
Promote to space
Create a deployment space
Use a space to collect assets in one place to create, run, and manage deployments
Find or create tags
Add tags to make assets easier to find
Storage
Cloud Object Storage-vj
Space will include integration with Cloud Object Storage for storing space assets.
watsonx.ai Runtime (optional)
watsonx.ai Runtime-zt
Advanced Settings
Cancel
Create


Service Details - IBM Cloud
P4 - Snap Random Forest Clas
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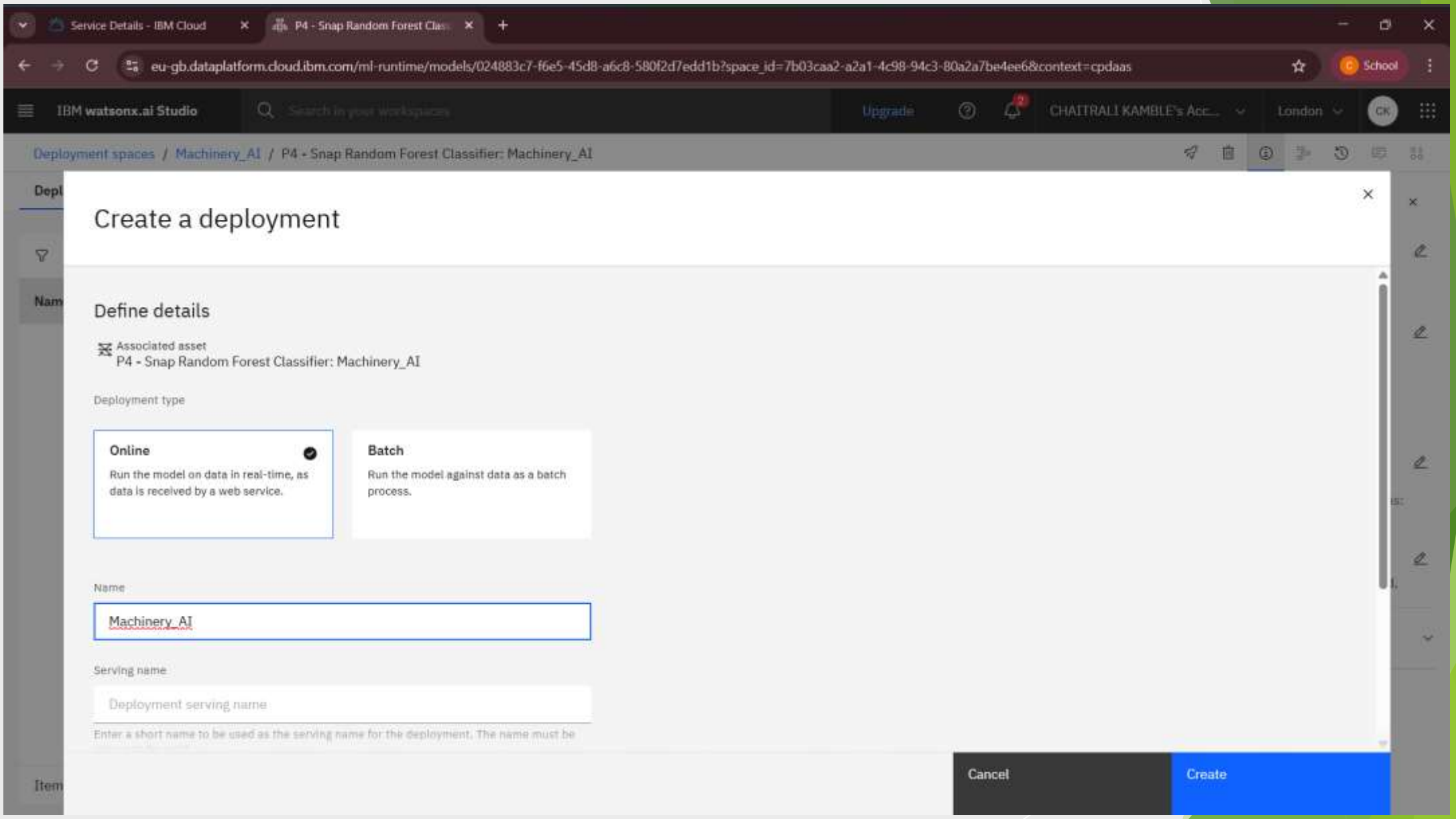
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acc...
London
Projects / machine_maintenance / P4 - Snap Random Forest Classifier: Machinery_AI
Promote to space
Promote the asset to a deployment space to deploy the asset or to support a deployment.
Success
Successfully promoted P4 - Snap Random Forest Classifier: Machinery_AI to the deployment space. Go to the deployment space to prepare the assets for deployment.
Timestamp 12:30:21 PM
Promotion completed.
Selected assets (1)
Name
Format
Version
Status
P4 - Snap Random Forest Classifier: Machinery_AI
Model
Current
Promoted
Promoting an asset promotes dependent assets as well. For example, promoting a model also promotes the associated software specification and package extensions. You will see all promoted assets in the target space.
Close


Service Details - IBM Cloud
P4 - Snap Random Forest Clas
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School
IBM watsonx.ai Studio
Upgrade
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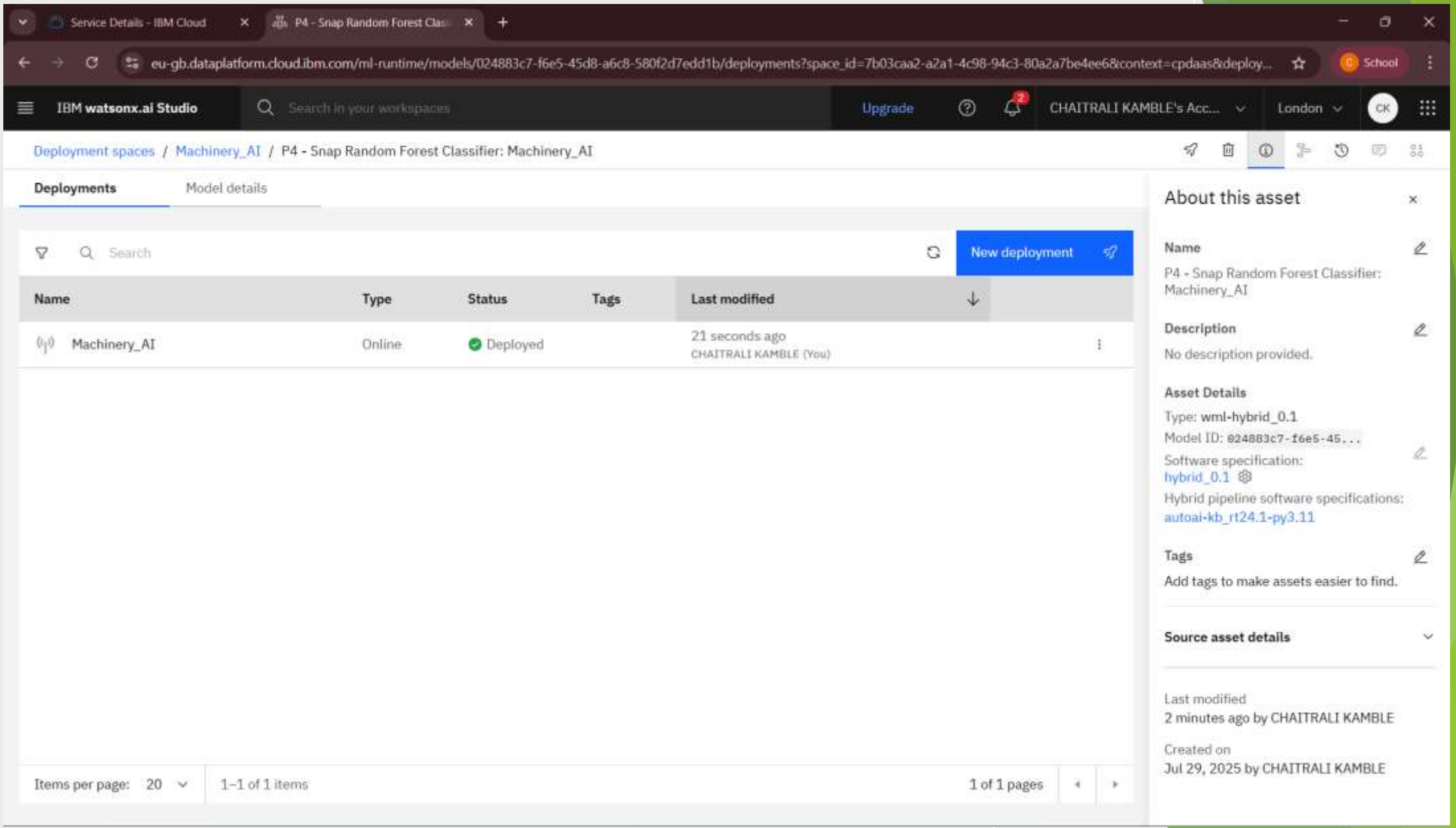
London
Deployment spaces / Machinery_AI / P4 - Snap Random Forest Classifier: Machinery_AI
Create a deployment
Define details
Associated asset
P4 - Snap Random Forest Classifier: Machinery_AI
Deployment type
Online
Run the model on data in real-time, as data is received by a web service.
Batch
Run the model against data as a batch process.
Name
Machinery_AI
Serving name
Deployment serving name
Enter a short name to be used as the serving name for the deployment. The name must be
Cancel
Create


Service Details - IBM Cloud
P4 - Snap Random Forest Clas
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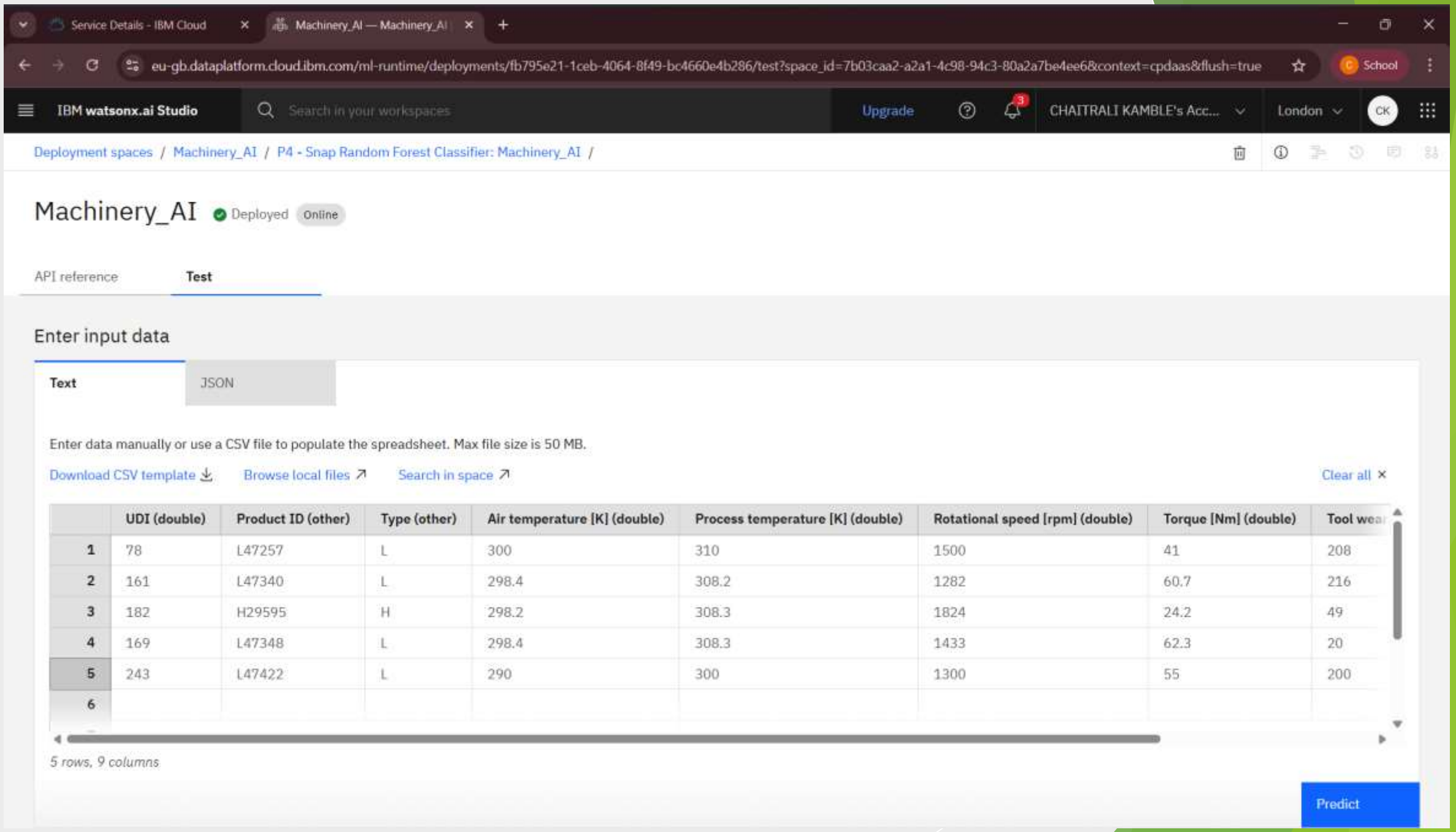
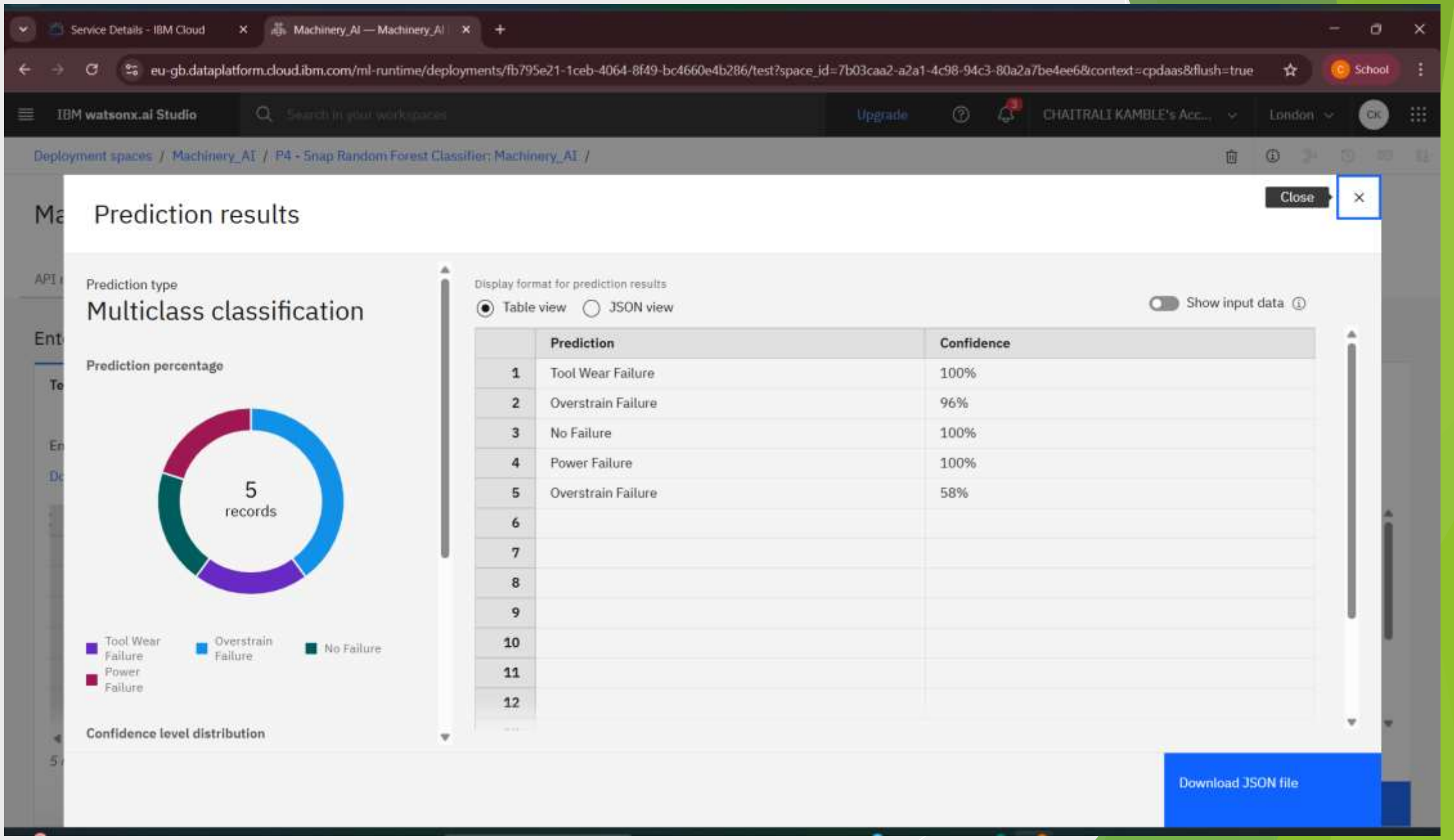
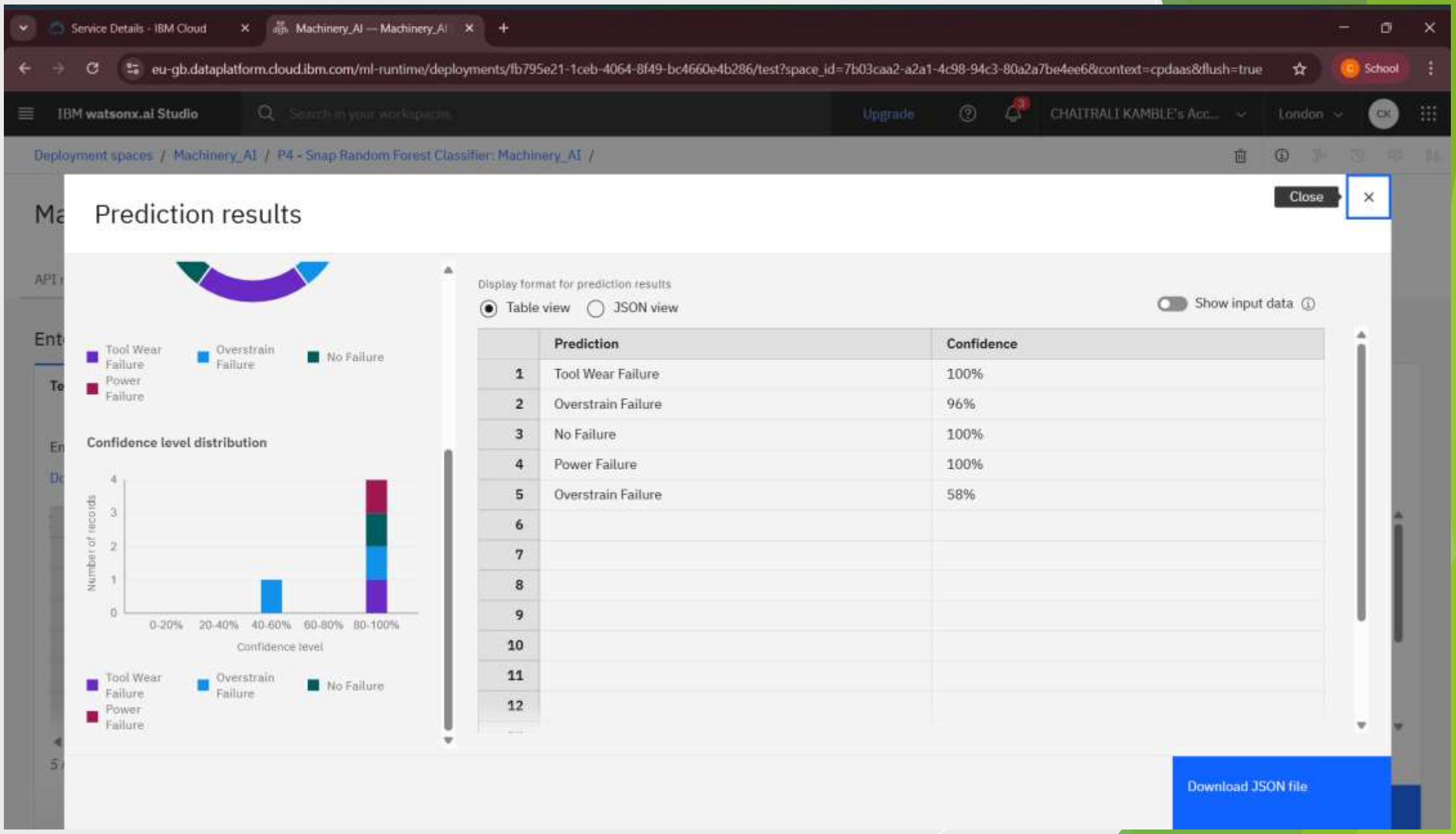
School
IBM watsonx.ai Studio
Search in your workspaces
Upgrade
CHAITRALI KAMBLE's Acc...
London
CK
Deployment spaces / Machinery_AI / P4 - Snap Random Forest Classifier: Machinery_AI
Deployments
Model details
Search
New deployment
Name
Type
Status
Tags
Last modified
Machinery_AI
Online
Deployed
21 seconds ago
CHAITRALI KAMBLE (You)
Items per page: 20
1–1 of 1 items
1 of 1 pages
About this asset
Name
P4 - Snap Random Forest Classifier: Machinery_AI
Description
No description provided.
Asset Details
Type: wml-hybrid_0.1
Model ID: 024883c7-f6e5-45...
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
2 minutes ago by CHAITRALI KAMBLE
Created on
Jul 29, 2025 by CHAITRALI KAMBLE



	UDI (double)	Product ID (other)	Type (other)	Air temperature [K] (double)	Process temperature [K] (double)	Rotational speed [rpm] (double)	Torque [Nm] (double)	Tool wear
1	78	L47257	L	300	310	1500	41	208
2	161	L47340	L	298.4	308.2	1282	60.7	216
3	182	H29595	H	298.2	308.3	1824	24.2	49
4	169	L47348	L	298.4	308.3	1433	62.3	20
5	243	L47422	L	290	300	1300	55	200
6								


Service Details - IBM Cloud
Machinery_AI — Machinery_AI
eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/fb795e21-1ceb-4064-8f49-bc4660e4b286/test?space_id=7b03caa2-a2a1-4c98-94c3-80a2a7be4ee6&context=cpdaas&flush=true
IBM watsonx.ai Studio
Upgrade
Deployment spaces / Machinery_AI / P4 - Snap Random Forest Classifier: Machinery_AI /
Prediction results
Close
Prediction type
Multiclass classification
Prediction percentage
5
records
Tool Wear Failure
Overstrain Failure
No Failure
Power Failure
Confidence level distribution
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 Tool Wear Failure 100%
2 Overstrain Failure 96%
3 No Failure 100%
4 Power Failure 100%
5 Overstrain Failure 58%
6
7
8
9
10
11
12
Download JSON file


Service Details - IBM Cloud
Machinery_AI — Machinery_AI
eu-gb.dataplatform.cloud.ibm.com/ml-runtime/deployments/fb795e21-1ceb-4064-8f49-bc4660e4b286/test?space_id=7b03caa2-a2a1-4c98-94c3-80a2a7be4ee68context=cpdaas&flush=true
IBM watsonx.ai Studio
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London
Deployment spaces / Machinery_AI / P4 - Snap Random Forest Classifier: Machinery_AI /
Prediction results
Close
Tool Wear Failure
Overstrain Failure
No Failure
Power Failure
Confidence level distribution
Number of records
0
1
2
3
4
0-20%
20-40%
40-60%
60-80%
80-100%
Confidence level
Tool Wear Failure
Overstrain Failure
No Failure
Power Failure
Display format for prediction results
Table view
JSON view
Show input data
Prediction
Confidence
1 Tool Wear Failure 100%
2 Overstrain Failure 96%
3 No Failure 100%
4 Power Failure 100%
5 Overstrain Failure 58%
6
7
8
9
10
11
12
Download JSON file

CONCLUSION

- Predictive maintenance models are essential for minimizing unexpected machine breakdowns .
- Use of machine learning and IBM Cloud services ensures scalability and real-time analysis.
- Reduces operational costs, increases machine lifespan, and improves production efficiency.

FUTURE SCOPE

- Integration with IoT sensors for real-time data streaming.
- Use of Deep Learning models for more accurate failure prediction.
- Expansion to multiple industrial sectors like manufacturing, automotive, aerospace.

REFERENCES

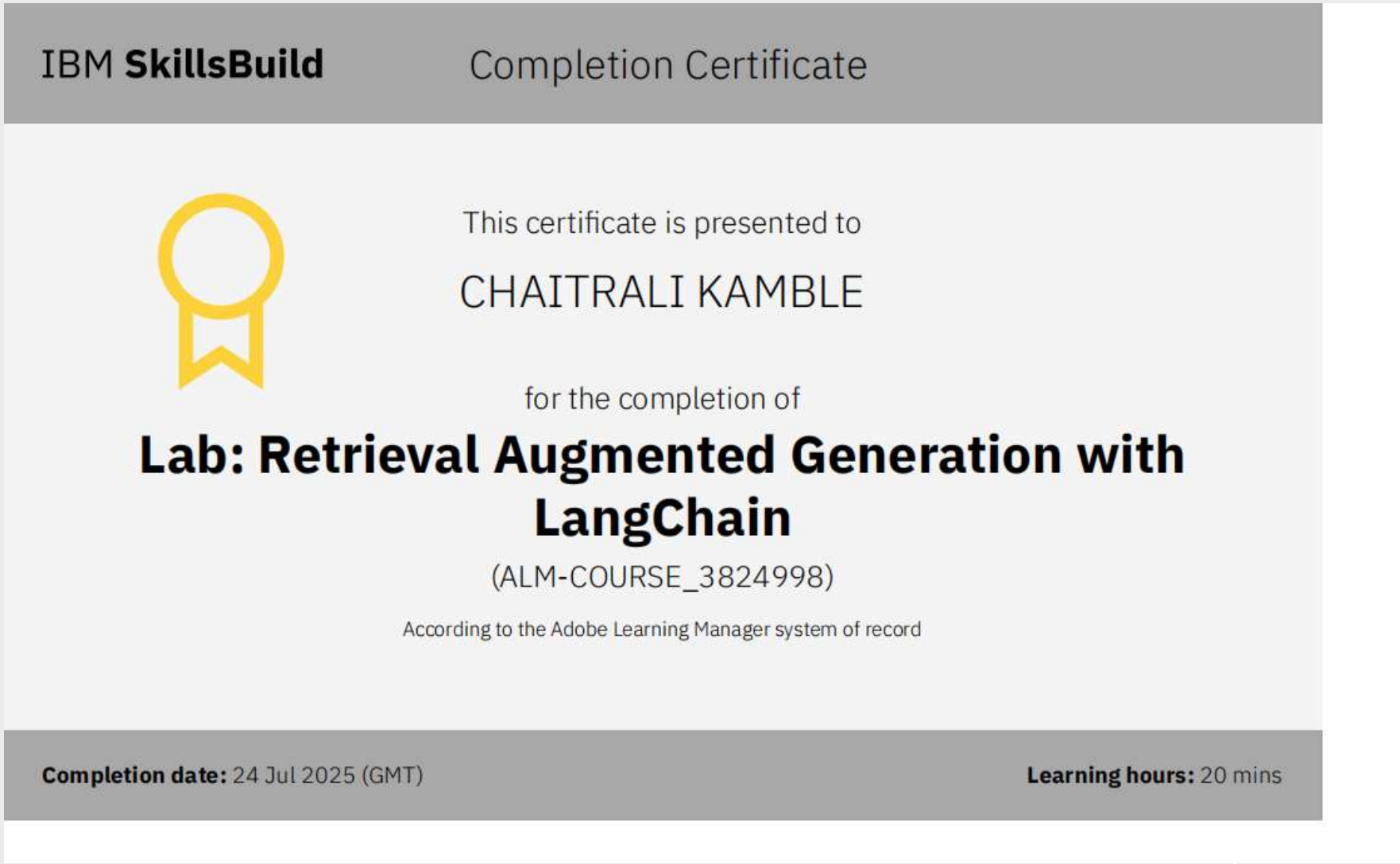
- Kaggle Dataset – Machine Predictive Maintenance Classification: https://www.kaggle.com/datasets/shivamb/machinepredictive-maintenance-classification
- Watsonx.ai.Studio Service of IBM Cloud Lite.
- Python libraries – Scikit-learn, Pandas, Matplotlib, Seaborn.

IBM CERTIFICATIONS

- Screenshot/ credly certificate(getting started with AI)

Screenshot/ credly certificate (Journey to Cloud)

Screenshot/ credly certificate(RAG Lab)



THANK YOU