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Abstract

Iris dataset model deployment

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Purpose

This document aims to guide stakeholders through the comprehensive process of deploying a machine learning model trained on the Iris dataset using Azure Machine Learning. It outlines each step from setting up the environment, training the model, and deploying it, to monitoring and maintaining the deployed model. The purpose is to ensure that stakeholders can replicate the deployment process effectively, understand the system architecture, and ensure the model performs reliably in a production environment.

Audience

This guide is intended for:

- Data Scientists**: To understand the deployment workflow and the integration of their models into production.**
- Developers**: To gain insights into how to manage and deploy machine learning models within Azure ML.**
- Operations Teams**: To ensure they can monitor and maintain the deployed models, handling scalability, performance, and security aspects.**

Dataset

The dataset used for this deployment is the Iris Flower Dataset, obtained from Kaggle. This dataset consists of 150 samples of iris flowers, categorized into three species: Virginica, Versicolor, and Setosa. Each sample includes measurements of four features:

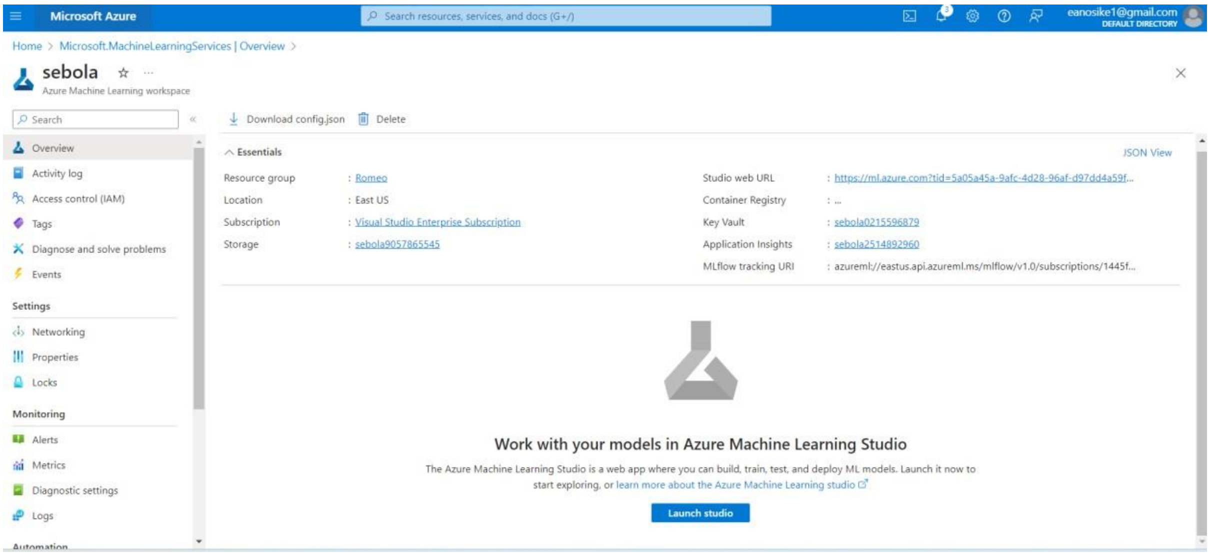
- Sepal Length
- Sepal Width
- Petal Length
- Petal Width

The primary goal is to develop a machine learning model capable of accurately classifying the species of an iris flower based on these features. This classic dataset is a popular choice for demonstrating various machine learning algorithms due to its simplicity and the clear separation of classes.

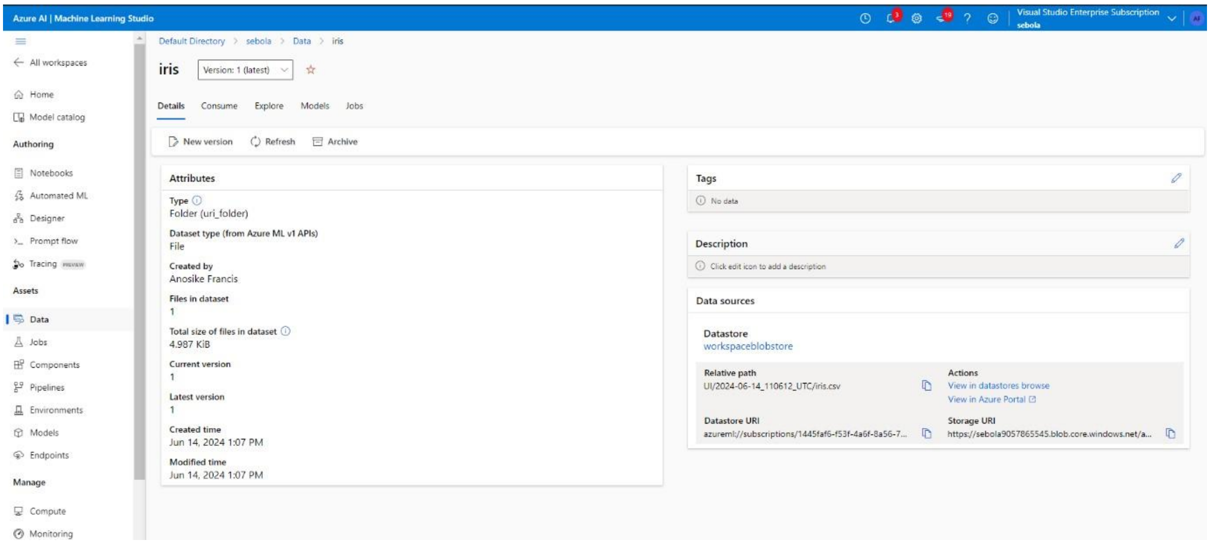
Importance of the Project

Deploying a machine learning model using the Iris dataset serves as an educational project, illustrating the key steps and best practices in machine learning model deployment. It highlights the use of Azure Machine Learning, a powerful cloud-based platform that simplifies the end-to-end machine learning process, from data preparation and model training to deployment and monitoring. Understanding this deployment process is crucial for professionals aiming to leverage machine learning in real-world applications, ensuring that models can be effectively transitioned from development to production.

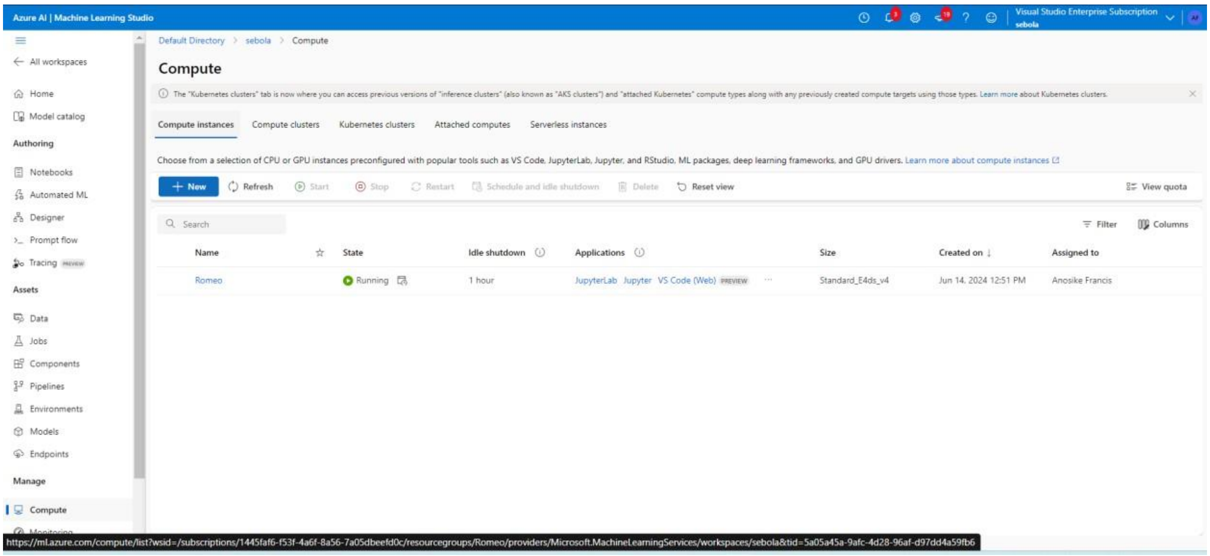
Create workspace



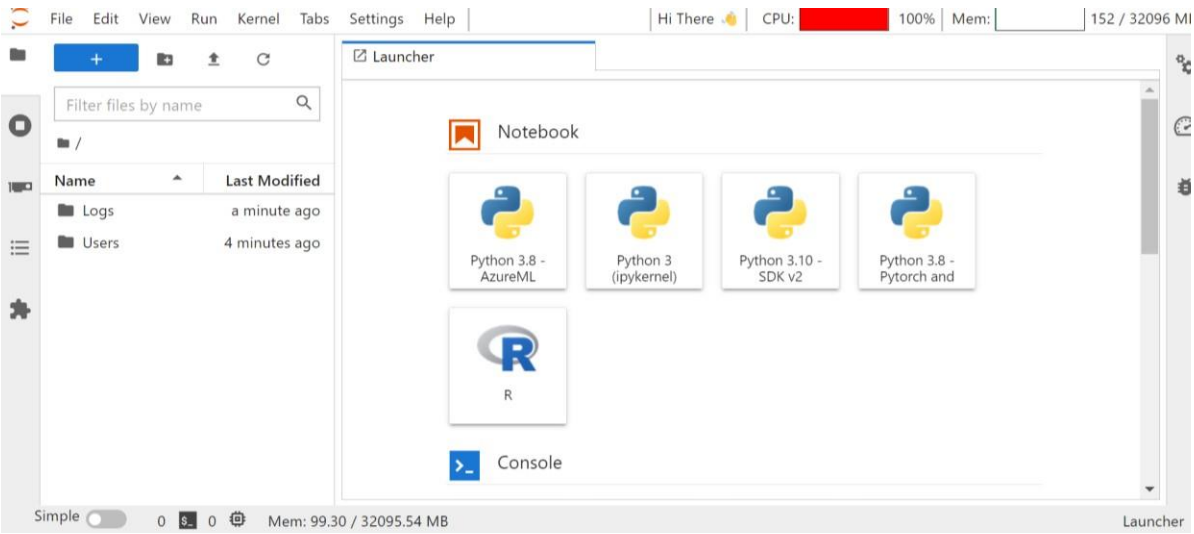
Upload the Iris dataset under Data component within the workspace.



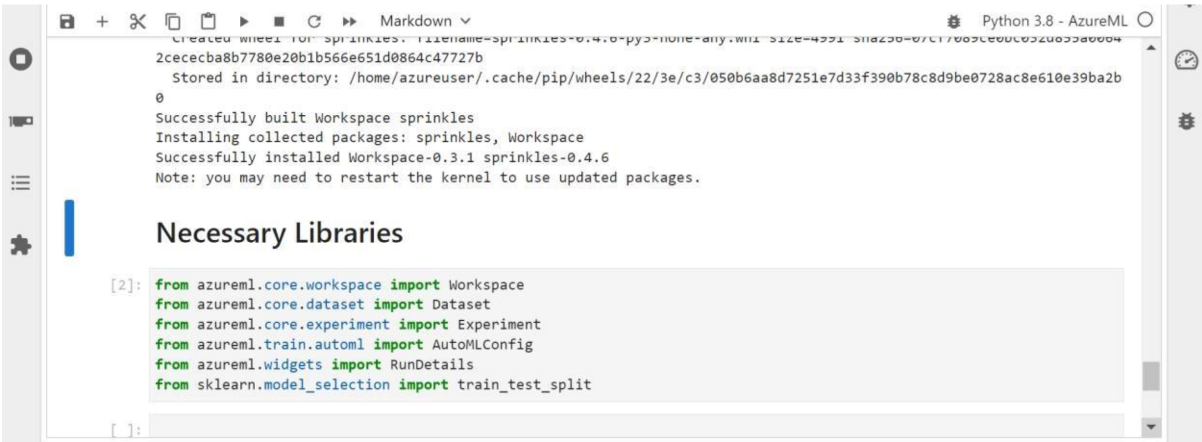
Create the compute instance and open the Jupyter Lab



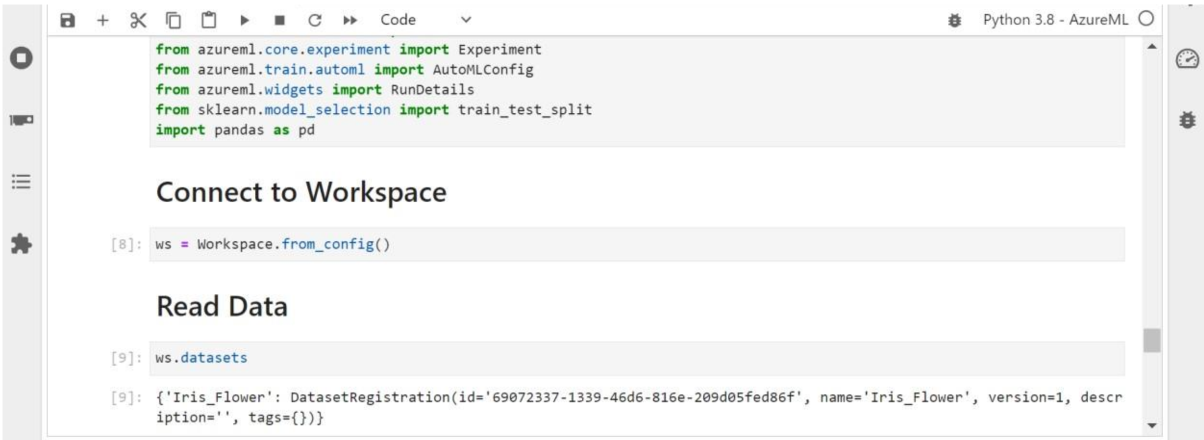
Use the python 3.8 Azure ML



Import the necessary packages and libraries



Connect to your workspaces



Work with the datasets and read your data.

Python 3.8 - AzureML

Read Data

```
[9]: ws.datasets
```

```
[9]: {'Iris_Flower': DatasetRegistration(id='69072337-1339-46d6-816e-209d05fed86f', name='Iris_Flower', version=1, descr
iption='', tags={})}
```

```
[10]: dataset = Dataset.get_by_name(workspace=ws, name = "Iris_Flower")
df_data = pd.read_csv("Iris.csv")
df_data
```

[10]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa

Python 3.8 - AzureML

```
[12]: dataset = Dataset.get_by_name(workspace=ws, name = "Iris_Flower")
df_data = pd.read_csv("Iris.csv")
df_data.head()
```

[12]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa

```
[11]: df_data.columns
```

```
[11]: Index(['sepal_length', 'sepal_width', 'petal_length', 'petal_width',
       'species'],
```

Train and split your data

Python 3.8 - AzureML

Split and Train Data

```
[13]: x_train, x_test = train_test_split(df_data, test_size = 0.2)
```

```
[14]: x_train.shape
```

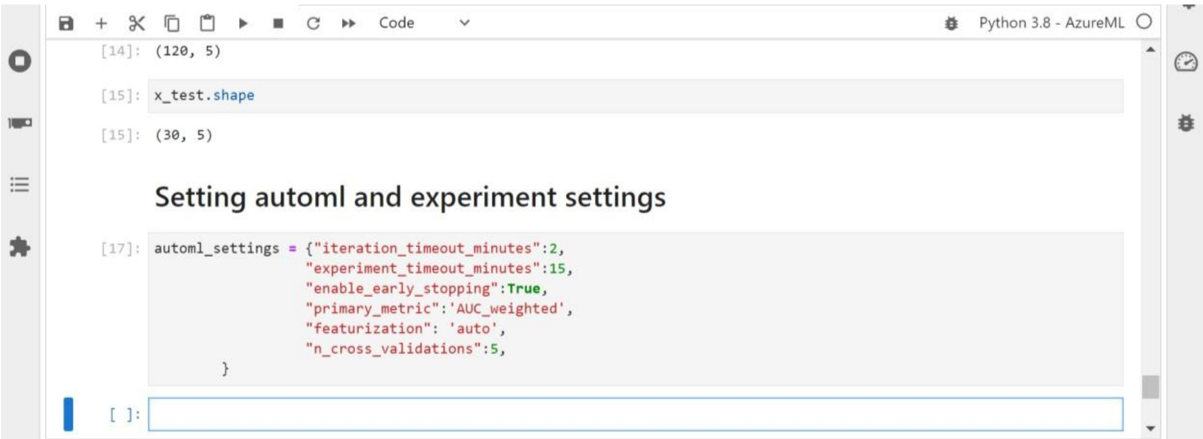
```
[14]: (120, 5)
```

```
[15]: x_test.shape
```

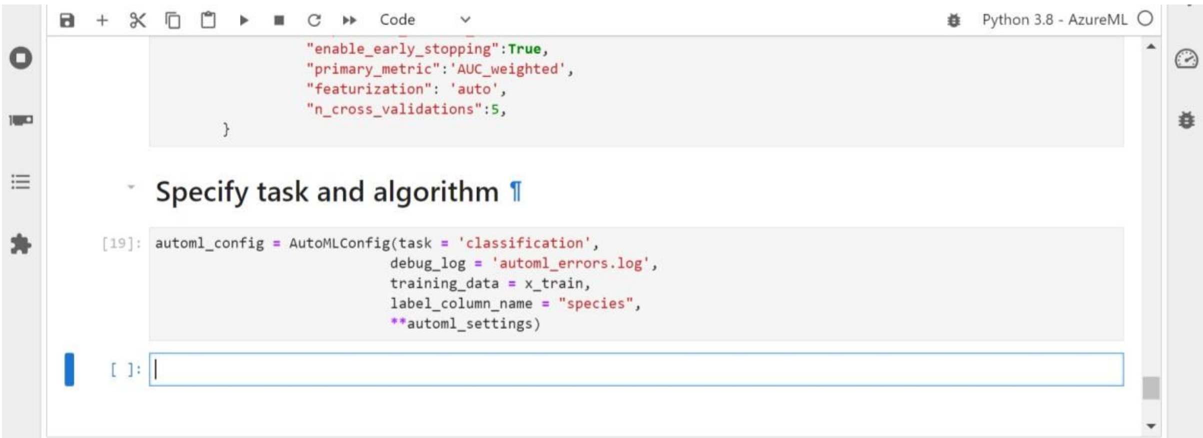
```
[15]: (30, 5)
```

```
[ ]:
```

Set up your automl and your experiments settings



Specify the task and algorithm to use and the specie column as your label



Create your experiment to use for deployment

Create Experiment for Deployment

```
[11]: experiment = Experiment(workspace = ws, name = "IrisFlower-Experiment")
```

```
[14]: pip install -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt
```

```
Requirement already satisfied: adal<=1.2.7 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 1)) (1.2.7)
Requirement already satisfied: applicationinsights<=0.11.10 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 2)) (0.11.10)
Requirement already satisfied: arch<=5.3.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 3)) (4.14)
Requirement already satisfied: argcomplete<=2.1.2 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 4)) (2.1.2)
Requirement already satisfied: attrs<=23.1.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 5)) (23.1.0)
Requirement already satisfied: azure-common<=1.1.28 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 6)) (1.1.28)
Requirement already satisfied: azure-core<=1.26.4 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 7)) (1.26.4)
Requirement already satisfied: azure-graphrbac<=0.61.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 8)) (0.60.0)
```

```
[14]: pip install -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt
```

```
Requirement already satisfied: adal<=1.2.7 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 1)) (1.2.7)
Requirement already satisfied: applicationinsights<=0.11.10 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 2)) (0.11.10)
Requirement already satisfied: arch<=5.3.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 3)) (4.14)
Requirement already satisfied: argcomplete<=2.1.2 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 4)) (2.1.2)
Requirement already satisfied: attrs<=23.1.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 5)) (23.1.0)
Requirement already satisfied: azure-common<=1.1.28 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 6)) (1.1.28)
Requirement already satisfied: azure-core<=1.26.4 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 7)) (1.26.4)
Requirement already satisfied: azure-graphrbac<=0.61.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 8)) (0.60.0)
Requirement already satisfied: azure-identity<=1.13.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 9)) (1.13.0)
Requirement already satisfied: azure-mgmt-authorization<=3.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 10)) (3.0.0)
Requirement already satisfied: azure-mgmt-containerregistry<=10.1.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 11)) (10.1.0)
Requirement already satisfied: azure-mgmt-core<=1.4.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 12)) (1.4.0)
Requirement already satisfied: azure-mgmt-keyvault<=10.2.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 13)) (10.2.1)
Requirement already satisfied: azure-mgmt-resource<=22.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 14)) (21.1.0b1)
Requirement already satisfied: azure-mgmt-storage<=21.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 15)) (21.0.0)
Requirement already satisfied: azure-storage-blob<=12.13.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/az
```

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Requirement already satisfied: azure-mgmt-storage<=21.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 15)) (21.0.0)
Requirement already satisfied: azure-storage-blob<=12.13.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 16)) (12.13.0)
Requirement already satisfied: azure-storage-queue<=12.6.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 17)) (12.6.0)
Requirement already satisfied: azureml-automl-core~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 18)) (1.51.0.post1)
Requirement already satisfied: azureml-automl-runtime~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 19)) (1.51.0.post1)
Requirement already satisfied: azureml-contrib-automl-pipeline-steps~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 20)) (1.51.0)
Requirement already satisfied: azureml-contrib-dataset~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 21)) (1.51.0)
Requirement already satisfied: azureml-core~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 22)) (1.51.0)
Requirement already satisfied: azureml-dataprep~=4.10.7 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 23)) (4.10.8)
Requirement already satisfied: azureml-dataprep-native~=38.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 24)) (38.0.0)
Requirement already satisfied: azureml-dataprep-rslex~=2.17.11 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 25)) (2.17.12)
Requirement already satisfied: azureml-dataset-runtime~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 26)) (1.51.0)
Requirement already satisfied: azureml-interpret~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 27)) (1.51.0)
Requirement already satisfied: azureml-mlflow~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 28)) (1.51.0)
Requirement already satisfied: azureml-pipeline-core~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 29)) (1.51.0)
Requirement already satisfied: azureml-pipeline-steps~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 30)) (1.51.0)
Requirement already satisfied: azureml-telemetry~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azur
```

```
azureml/automl/core/validated_linux_requirements.txt (line 29)) (1.51.0)
Requirement already satisfied: azureml-pipeline-steps~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 30)) (1.51.0)
Requirement already satisfied: azureml-telemetry~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 31)) (1.51.0)
Requirement already satisfied: azureml-train-automl-client~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 32)) (1.51.0.post1)
Requirement already satisfied: azureml-train-automl-runtime~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 33)) (1.51.0.post2)
Requirement already satisfied: azureml-train-core~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 34)) (1.51.0)
Requirement already satisfied: azureml-train-restclients-hyperdrive~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 35)) (1.51.0)
Requirement already satisfied: azureml-training-tabular~=1.51.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 36)) (1.51.0.post1)
Requirement already satisfied: backports.tempfile<=1.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 37)) (1.0)
Requirement already satisfied: backports.weakref<=1.0.post1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 38)) (1.0.post1)
Requirement already satisfied: bcrypt<=4.0.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 39)) (4.0.1)
Requirement already satisfied: bokeh<=2.4.3 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 40)) (2.4.3)
Requirement already satisfied: boto<=2.49.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 41)) (2.49.0)
Requirement already satisfied: boto3<=1.20.19 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 42)) (1.20.19)
Requirement already satisfied: botocore<=1.23.19 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 43)) (1.23.19)
Requirement already satisfied: certifi<=2023.5.7 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 44)) (2022.9.24)
Requirement already satisfied: cffi<=1.15.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 45)) (1.15.1)
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Code　Python 3.8 - AzureML

```
Requirement already satisfied: tornado<=6.3.2 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 150)) (6.3.2)
Requirement already satisfied: tqdm<=4.65.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 151)) (4.65.0)
Requirement already satisfied: typing-extensions<=4.6.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 152)) (4.6.0)
Requirement already satisfied: urllib3<=1.26.16 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 153)) (1.26.16)
Requirement already satisfied: websocket-client<=1.5.2 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 154)) (1.3.3)
Requirement already satisfied: zict<=3.0.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 155)) (3.0.0)
Requirement already satisfied: zipp<=3.15.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from -r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 156)) (3.12.0)
Requirement already satisfied: wheel in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from lightgbm<=3.2.1->-r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 83)) (0.37.1)
Requirement already satisfied: setuptools in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from numba<=0.55.2->-r /anaconda/envs/azureml_py38/lib/python3.8/site-packages/azureml/automl/core/validated_linux_requirements.txt (line 95)) (65.6.3)
ERROR: responsibleai 0.27.0 has requirement ipykernel<=6.8.0, but you'll have ipykernel 6.22.0 which is incompatible.
ERROR: rai-core-flask 0.6.0 has requirement gevent>=21.12.0, but you'll have gevent 1.3.6 which is incompatible.
ERROR: rai-core-flask 0.6.0 has requirement Werkzeug<=2.2.3, but you'll have werkzeug 2.3.4 which is incompatible.
ERROR: nbconvert 7.4.0 has requirement jinja2>=3.0, but you'll have jinja2 2.11.2 which is incompatible.
ERROR: jupyterlab 3.2.4 has requirement jupyter-server~=1.4, but you'll have jupyter-server 2.5.0 which is incompatible.
ERROR: jupyterlab 3.2.4 has requirement nbclassic~=0.2, but you'll have nbclassic 1.0.0 which is incompatible.
ERROR: flask 2.3.2 has requirement Jinja2>=3.1.2, but you'll have jinja2 2.11.2 which is incompatible.
ERROR: dask-sql 2023.6.0 has requirement pandas>=1.4.0, but you'll have pandas 1.1.5 which is incompatible.
ERROR: azureml-inference-server-http 0.8.4 has requirement flask<2.3.0, but you'll have flask 2.3.2 which is incompatible.
Installing collected packages: MarkupSafe
  Attempting uninstall: MarkupSafe
    Found existing installation: MarkupSafe 2.1.5
    Uninstalling MarkupSafe-2.1.5:
      Successfully uninstalled MarkupSafe-2.1.5
Successfully installed MarkupSafe-2.1.2
```

Code　Python 3.8 - AzureML

```
ERROR: jupyterlab 3.2.4 has requirement nbclassic~=0.2, but you'll have nbclassic 1.0.0 which is incompatible.
ERROR: flask 2.3.2 has requirement Jinja2>=3.1.2, but you'll have jinja2 2.11.2 which is incompatible.
ERROR: dask-sql 2023.6.0 has requirement pandas>=1.4.0, but you'll have pandas 1.1.5 which is incompatible.
ERROR: azureml-inference-server-http 0.8.4 has requirement flask<2.3.0, but you'll have flask 2.3.2 which is incompatible.
Installing collected packages: MarkupSafe
  Attempting uninstall: MarkupSafe
    Found existing installation: MarkupSafe 2.1.5
    Uninstalling MarkupSafe-2.1.5:
      Successfully uninstalled MarkupSafe-2.1.5
Successfully installed MarkupSafe-2.1.2
Note: you may need to restart the kernel to use updated packages.
```

```
[17]: pip install markupsafe==2.0.1
```

```
Collecting markupsafe==2.0.1
  Downloading MarkupSafe-2.0.1-cp38-cp38-manylinux2010_x86_64.whl (30 kB)
ERROR: werkzeug 2.3.4 has requirement MarkupSafe>=2.1.1, but you'll have markupsafe 2.0.1 which is incompatible.
ERROR: responsibleai 0.27.0 has requirement ipykernel<=6.8.0, but you'll have ipykernel 6.22.0 which is incompatible.
ERROR: rai-core-flask 0.6.0 has requirement gevent>=21.12.0, but you'll have gevent 1.3.6 which is incompatible.
ERROR: rai-core-flask 0.6.0 has requirement Werkzeug<=2.2.3, but you'll have werkzeug 2.3.4 which is incompatible.
ERROR: nbconvert 7.4.0 has requirement jinja2>=3.0, but you'll have jinja2 2.11.2 which is incompatible.
ERROR: jupyterlab 3.2.4 has requirement jupyter-server~=1.4, but you'll have jupyter-server 2.5.0 which is incompatible.
ERROR: jupyterlab 3.2.4 has requirement nbclassic~=0.2, but you'll have nbclassic 1.0.0 which is incompatible.
ERROR: flask 2.3.2 has requirement Jinja2>=3.1.2, but you'll have jinja2 2.11.2 which is incompatible.
ERROR: dask-sql 2023.6.0 has requirement pandas>=1.4.0, but you'll have pandas 1.1.5 which is incompatible.
ERROR: azureml-inference-server-http 0.8.4 has requirement flask<2.3.0, but you'll have flask 2.3.2 which is incompatible.
Installing collected packages: markupsafe
Successfully installed markupsafe-2.0.1
Note: you may need to restart the kernel to use updated packages.
```

```
[*]: run = experiment.submit(automl_config, show_output=True)
```

```
No run_configuration provided, running on local with default configuration
Running in the active local environment.
```

Code　Python 3.8 - AzureML

```
[12]: run = experiment.submit(automl_config, show_output=True)
```

```
No run_configuration provided, running on local with default configuration
Running in the active local environment.
```

Experiment	Id	Type	Status	Details Page	Docs Page
IrisFlower-Experiment	AutoML_0546dc55-4f98-4746-ac04-1cc6fa8e89e7	automl	Preparing	Link to Azure Machine Learning studio	Link to Documentation

```
Current status: DatasetEvaluation. Gathering dataset statistics.
Current status: FeaturesGeneration. Generating features for the dataset.
Current status: DatasetFeaturization. Beginning to fit featurizers and featurize the dataset.
Current status: DatasetFeaturizationCompleted. Completed fit featurizers and featurizing the dataset.
Current status: DatasetCrossValidationSplit. Generating individually featurized CV splits.
2024/06/12 07:35:02 WARNING mlflow.sklearn: Model was missing function: predict. Not logging python_function flavor!

********************************************************************************************
DATA GUARDRAILS:

TYPE:         Class balancing detection
STATUS:       PASSED
DESCRIPTION:  Your inputs were analyzed, and all classes are balanced in your training data.
              Learn more about imbalanced data: https://aka.ms/AutomatedMLImbalancedData

********************************************************************************************

TYPE:         Missing feature values imputation
STATUS:       PASSED
DESCRIPTION:  No feature missing values were detected in the training data.
              Learn more about missing value imputation: https://aka.ms/AutomatedMLFeaturization

********************************************************************************************
```

Share this window

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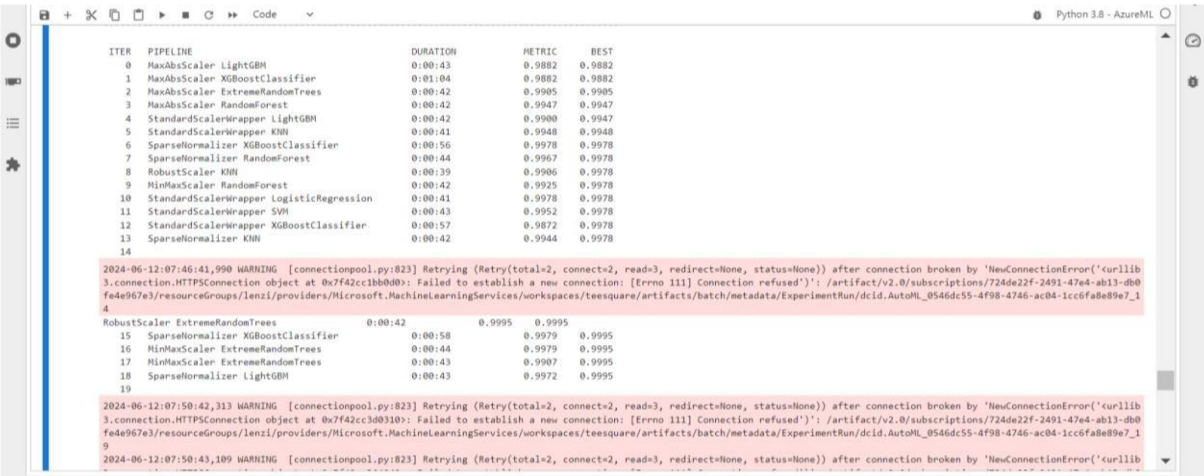
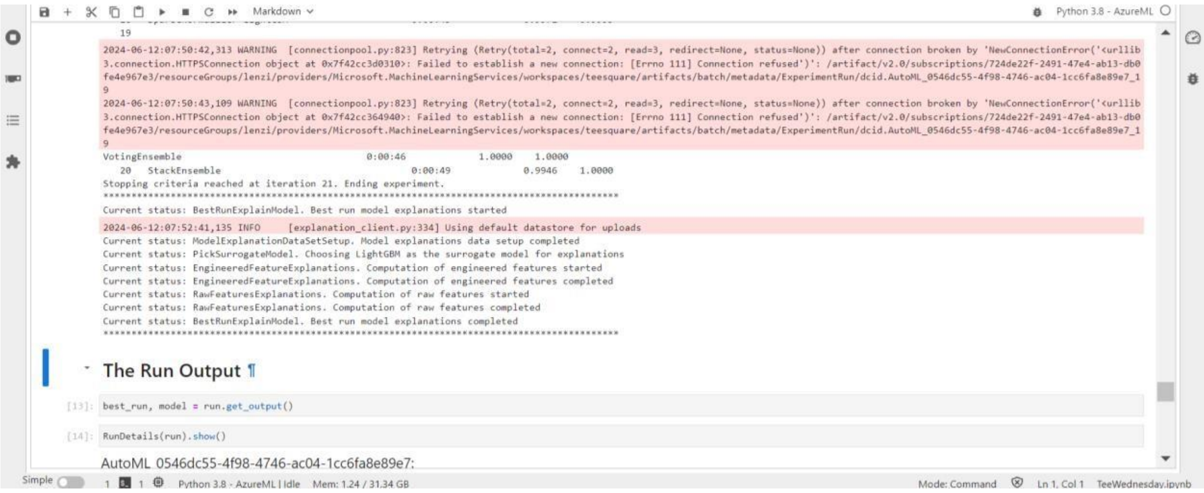
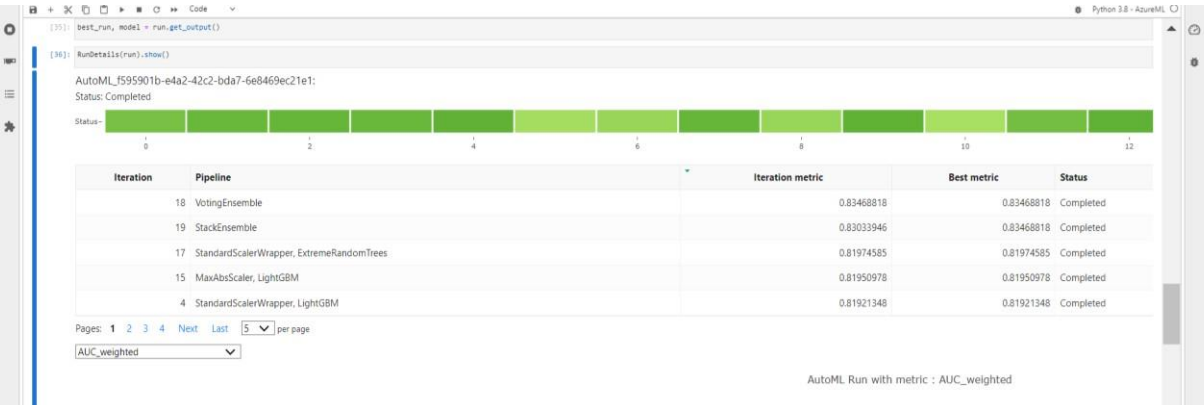
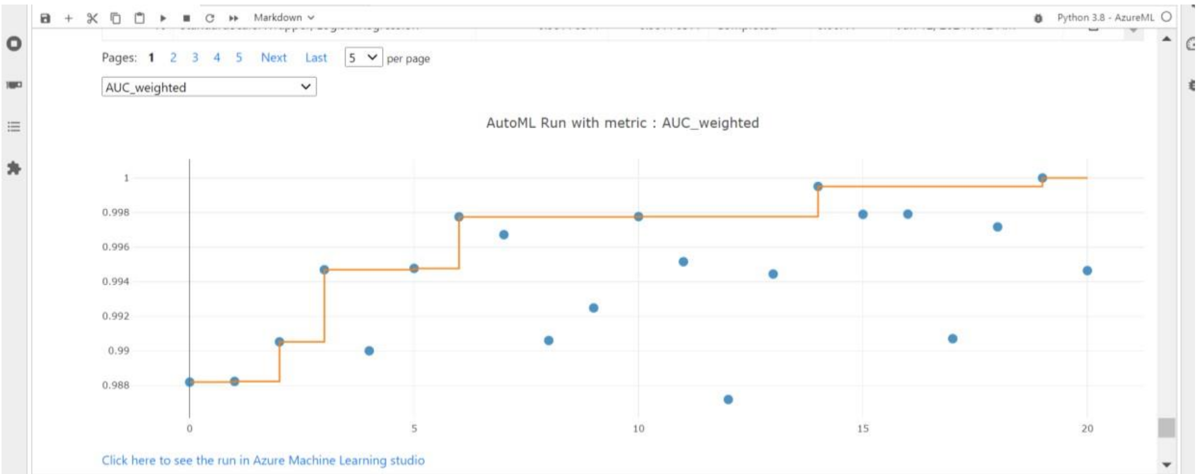
```
********************************************************************************************

TYPE:         High cardinality feature detection
STATUS:       PASSED
DESCRIPTION:  Your inputs were analyzed, and no high cardinality features were detected.
              Learn more about high cardinality feature handling: https://aka.ms/AutomatedMLFeaturization

********************************************************************************************
Current status: ModelSelection. Beginning model selection.

********************************************************************************************
ITER: The iteration being evaluated.
PIPELINE: A summary description of the pipeline being evaluated.
DURATION: Time taken for the current iteration.
METRIC: The result of computing score on the fitted pipeline.
BEST: The best observed score thus far.
********************************************************************************************

 ITER   PIPELINE                                       DURATION            METRIC      BEST
    0   MaxAbsScaler LightGBM                          0:00:43             0.9882    0.9882
    1   MaxAbsScaler XGBoostClassifier                 0:01:04             0.9882    0.9882
    2   MaxAbsScaler ExtremeRandomTrees                0:00:42             0.9905    0.9905
    3   MaxAbsScaler RandomForest                      0:00:42             0.9947    0.9947
    4   StandardScalerWrapper LightGBM                 0:00:42             0.9900    0.9947
    5   StandardScalerWrapper KNN                      0:00:41             0.9948    0.9948
    6   SparseNormalizer XGBoostClassifier             0:00:56             0.9978    0.9978
    7   SparseNormalizer RandomForest                  0:00:44             0.9967    0.9978
    8   RobustScaler KNN                               0:00:39             0.9906    0.9978
    9   MinMaxScaler RandomForest                      0:00:42             0.9925    0.9978
   10   StandardScalerWrapper LogisticRegression       0:00:41             0.9978    0.9978
   11   StandardScalerWrapper SVM                      0:00:43             0.9952    0.9978
   12   StandardScalerWrapper XGBoostClassifier        0:00:57             0.9872    0.9978
```



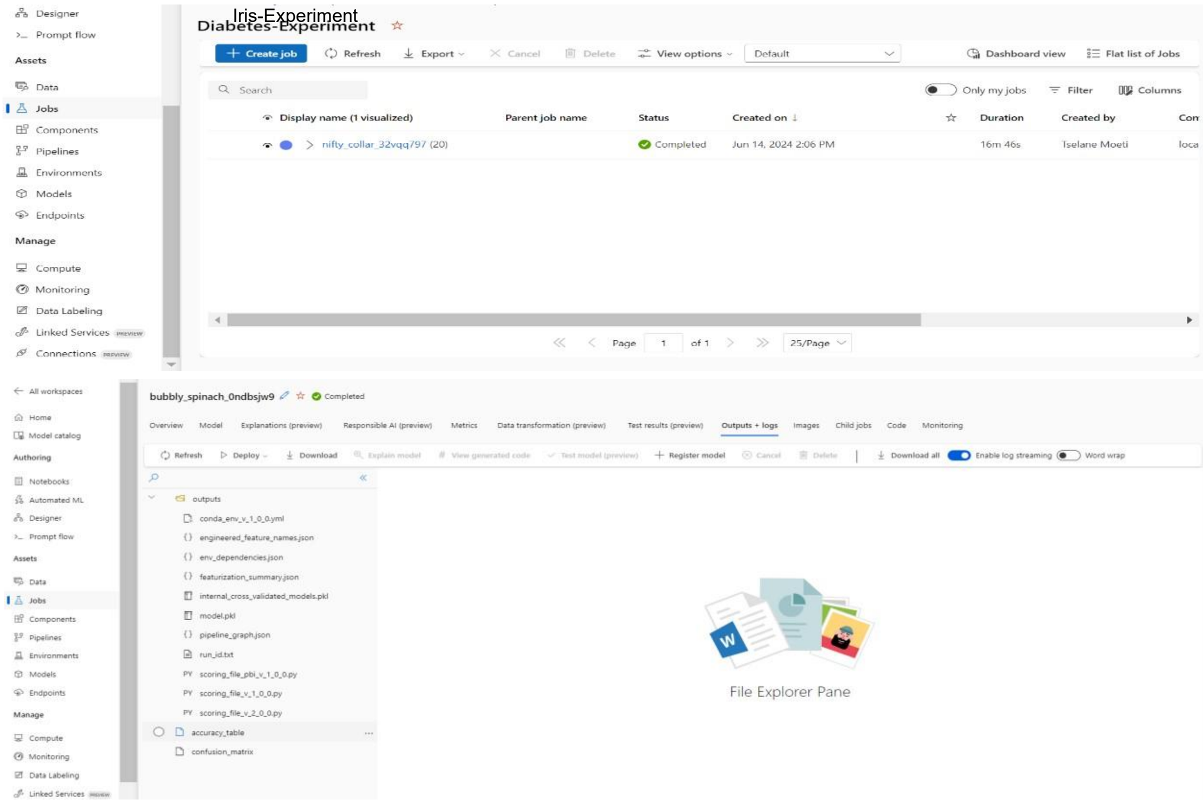


Get the run output

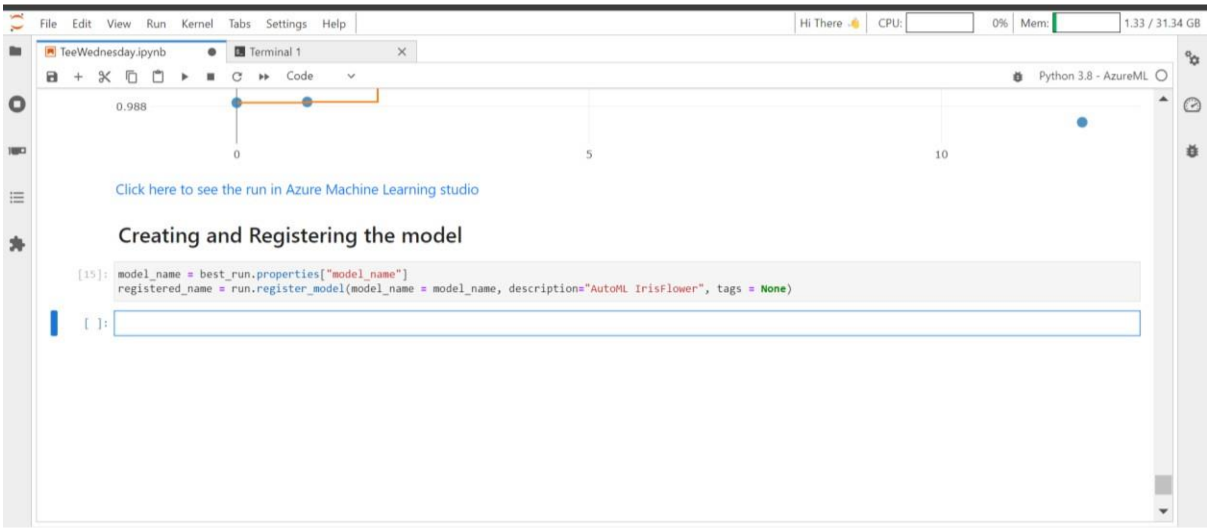


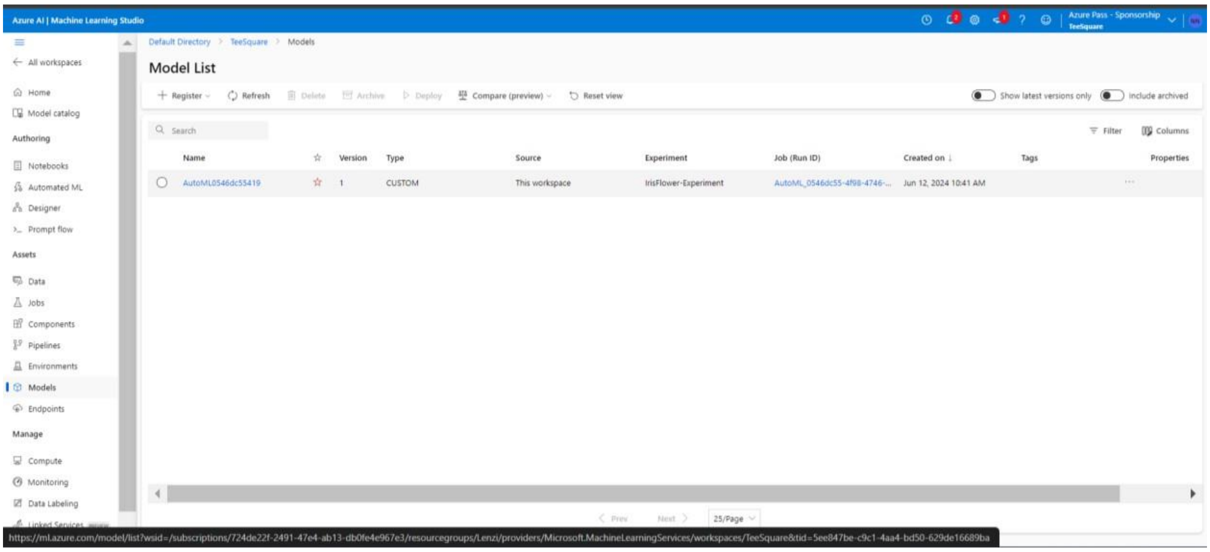


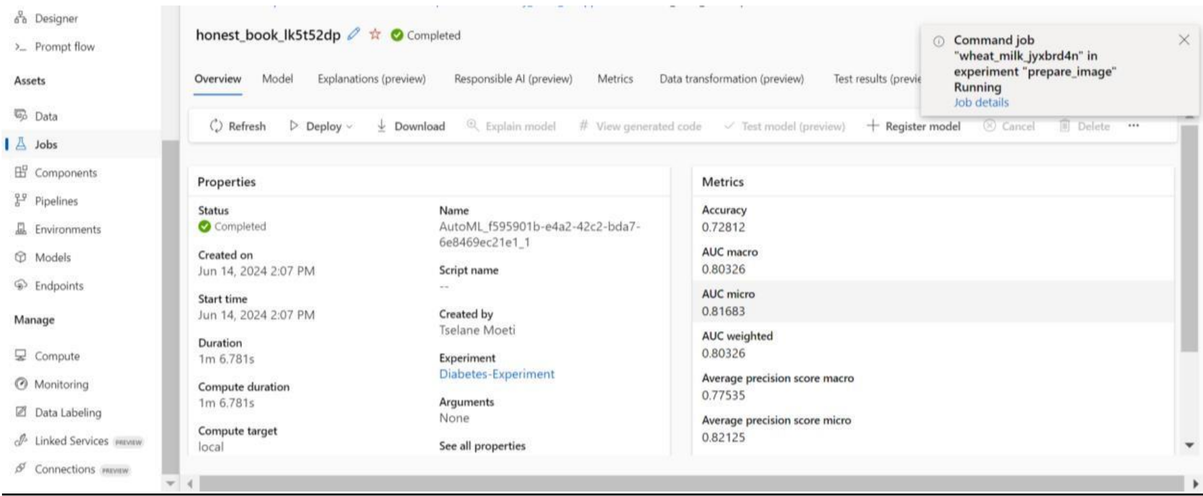
See the experiment and the scoring file created



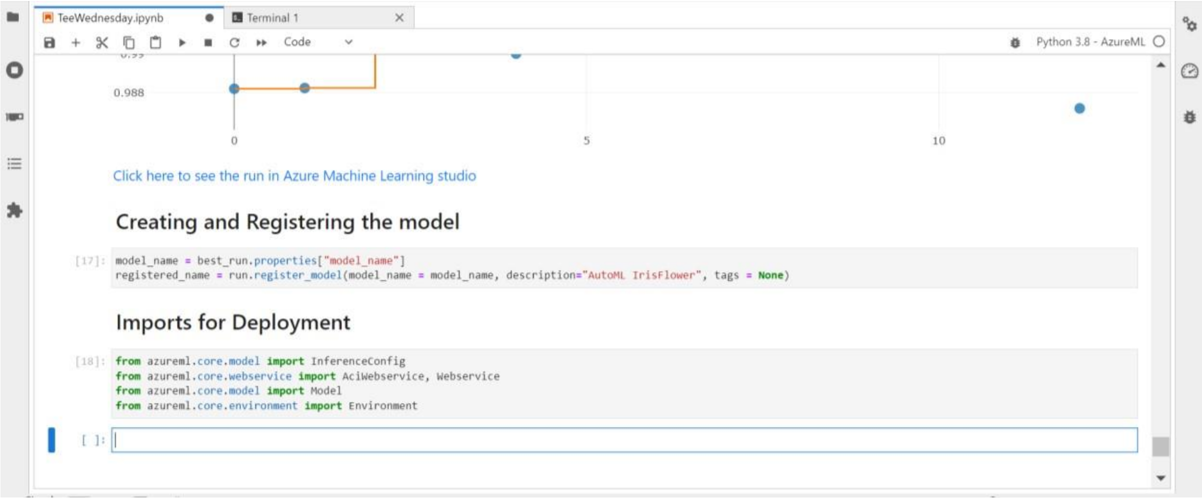
Create and register your model







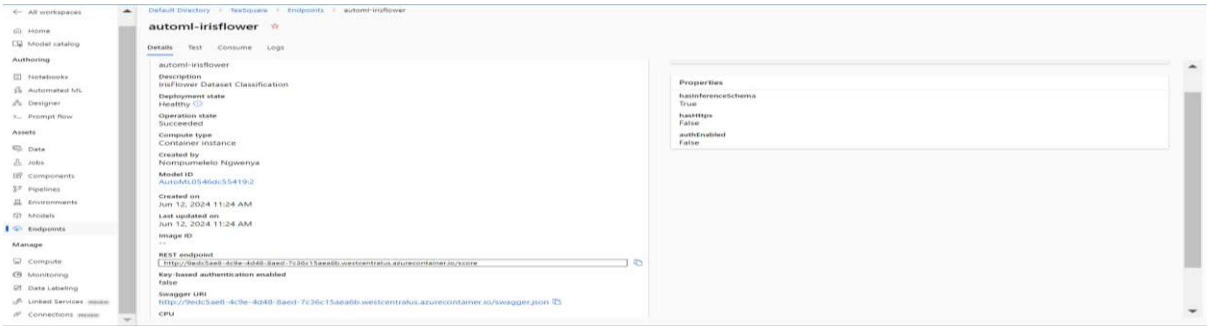
Import the packages for deployments



Download and bring in the scored .py file

Step 17: Deploying

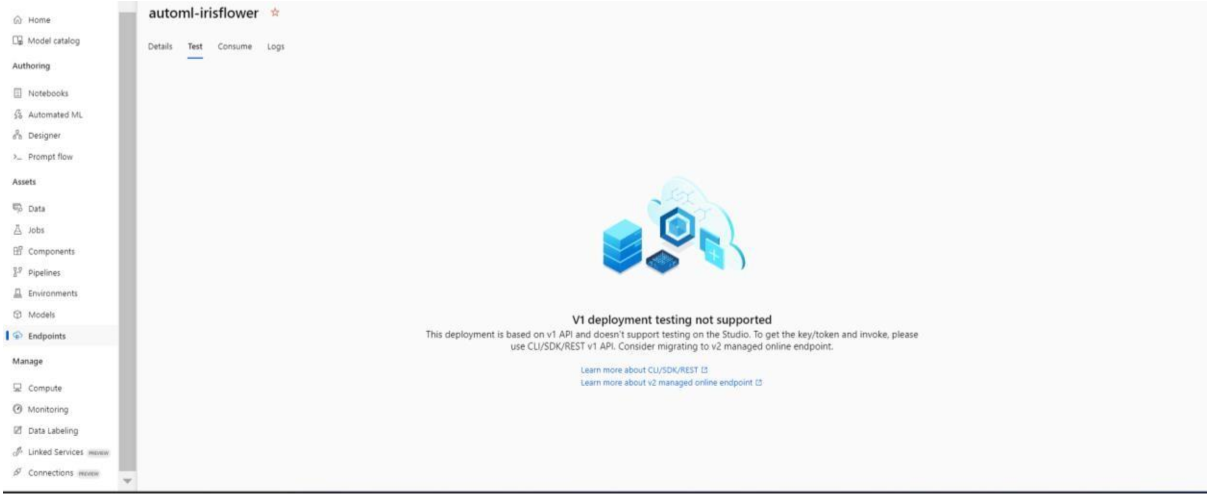
Look at the completed deployment and copy the url link and test it



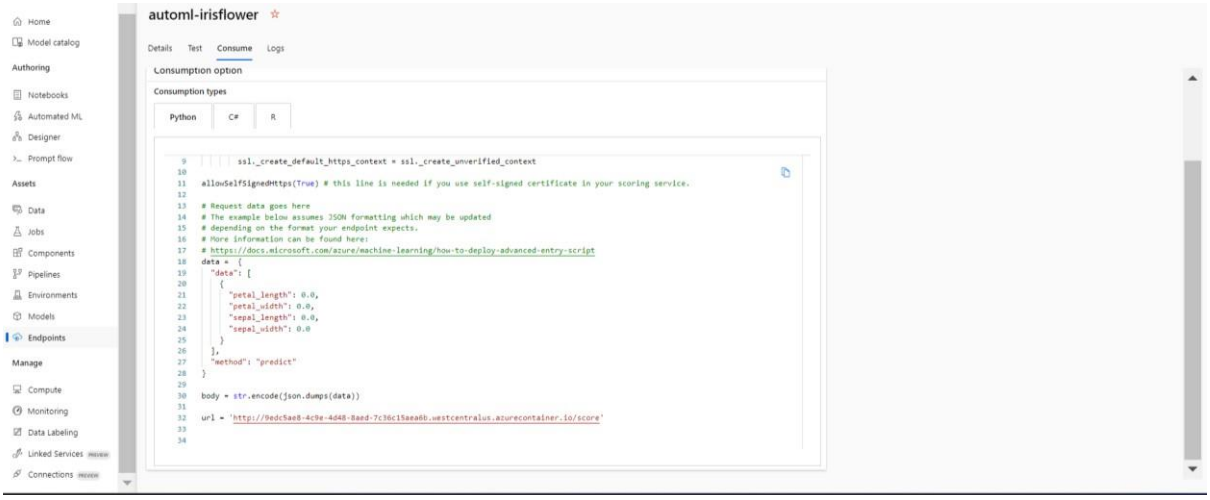
http://9edc5ae8-4c9e-4d48-8aed-7c36c15aea6b.westcentralus.azurecontainer.io/score

Step 19

Test the predicted result



Consume the endpoints



Testing and Validation

Dataset

- Iris Dataset: **Available at Kaggle.**

Testing Procedure

To ensure the deployed model functions as expected, follow these steps:

1. Environment Configuration: **Set up the required environment and dependencies for testing.**
2. Data Preparation: **Prepare the input data, ensuring it aligns with the model's requirements.**
3. Input Data Validation: **Validate the input data to ensure it is in the correct format and free of errors.**
4. Testing: **Use typical examples of data the model will encounter in production to test its predictions.**
5. Prediction Output & Accuracy Assessment: **Evaluate the accuracy of the model's predictions against known results.**
6. Performance Testing: **Measure the model's latency and throughput to ensure it meets performance standards.**
7. Integration Testing: **Test the model's integration with other system components to ensure seamless operation.**

8. Validation Against Baselines: **Compare the model's performance against baseline metrics to validate its effectiveness.**
9. Bias and Fairness Testing: **(If applicable) Assess the model for biases and fairness in its predictions.**
10. Documentation of Testing Results: **Document all testing results for future reference and accountability.**
11. Model Refinement: **Based on testing outcomes, iteratively refine the model to address any issues or performance gaps.**

Monitoring and Logging

Effective monitoring and logging are essential for maintaining the performance and health of the deployed model. Azure provides several tools and services to facilitate this.

Azure Monitor

- Metrics: **Collect performance metrics such as CPU usage, memory usage, and response times of the deployed model endpoint.**
- Alerts: **Set up alerts based on predefined thresholds for metrics (e.g., response time exceeding a certain limit).**
- Logs: **Collect logs from various Azure services, including Application Insights and Azure Machine Learning, to gain deeper insights into model performance.**

Azure Monitor Logs

- Querying Logs: **Use Azure Monitor Logs to query and analyze logs collected from various Azure services.**
- Log Analytics: **Leverage Log Analytics to perform advanced queries, create dashboards, and gain insights into the operational health of the deployed model.**

Scalability and Performance

Scalability Considerations

To ensure the model can handle increased traffic or larger datasets on Azure, consider the following:

- Compute Resources
- Auto-scaling
- Data Storage Solutions
- Load Balancing
- Caching Strategies

Performance Optimization

Optimize the model's performance by enhancing its speed, efficiency, and resource utilization through:

- Model Optimization

- Hardware Acceleration
- Batch Processing
- Model Compression
- Pipeline Optimization
- Benchmarking and Monitoring

Security Considerations

Security Measures

Implement robust security measures to protect data, maintain privacy, and comply with regulatory requirements:

- Authentication and Authorization
- Network Security
- Data Encryption

Compliance

Ensure compliance with regulatory standards, data privacy, and ethical considerations:

- Regulatory Compliance
- Data Privacy
- Audit and Compliance Reporting
- Legal and Ethical Considerations

Maintenance and Support

Maintenance Guidelines

Maintain and update the deployed model regularly to ensure its continued effectiveness:

- Version Control
- Monitoring and Performance Evaluation
- Regular Updates and Retraining
- Security Updates

Troubleshooting

Document common issues and their corresponding troubleshooting steps to efficiently resolve any problems that may arise:

- **Problem**: Inaccurate model predictions due to changes in input data quality or distribution.
    - Solution**: Implement data drift monitoring and periodically retrain the model using updated datasets.**
- **Problem**: Unauthorized access or data breach related to Azure resources hosting the model.
    - Solution**: Review Azure Security Center alerts and audit logs for suspicious activities. Implement Azure AD authentication and RBAC to restrict access.**

Conclusion

Deploying a machine learning model using Azure Machine Learning involves a structured process that ensures the model is not only effectively trained but also robustly deployed and maintained. By following the steps outlined in this guide, stakeholders can seamlessly transition from development to production, leveraging Azure's comprehensive suite of tools and services.