# Creating AutoML with Azure Python SDK

Reference :

1. https://github.com/binodsuman/azure_ml (https://github.com/binodsuman/azure_ml) (OG Content)
2. https://learn.microsoft.com/en-us/training/modules/intro-to-azure-machine-learning-service/4-azure-ml-experiment (https://learn.microsoft.com/en-us/training/modules/intro-to-azure-machine-learning-service/4-azure-ml-experiment)
3. https://www.youtube.com/watch?v=Lxdui2F2Zw8&ab_channel=AmbarishGanguly (https://www.youtube.com/watch?v=Lxdui2F2Zw8&ab_channel=AmbarishGanguly) (Datastore)
4. https://github.com/anikch/azure-ml (https://github.com/anikch/azure-ml)
5. MLOPS : https://www.sqlservergeeks.com/azure-machine-learning-for-mlops-by-mercy-ranjith/" (https://www.sqlservergeeks.com/azure-machine-learning-for-mlops-by-mercy-ranjith/")

**STEP 1:** Go to azure and create an account from https://portal.azure.com/#home (https://portal.azure.com/#home)
**STEP 2 :** Go to Anaconda and create an environment to work with azure ML specifically.

Follow the steps to create a virtual env in Azure:

- Create an environment : conda create --name azure_ml_env
- Activate the virtual env : conda activate azure_ml_env

**STEP 3:** Install python azure-ml sdk : pip install azureml-sdk
This step takes time and if some of the installation fails, do upgrade pip version by the command : python -m pip install --upgrade pip

In [1]:
```
pip show azureml-sdk  ### To show azureml-sdk version
```

```
Name: azureml-sdk
Version: 1.49.0
Summary: Used to build and run machine learning workflows upon the     Azur
e Machine Learning service.
Home-page: https://docs.microsoft.com/python/api/overview/azure/ml/?view=az
ure-ml-py (https://docs.microsoft.com/python/api/overview/azure/ml/?view=az
ure-ml-py)
Author: Microsoft Corp
Author-email:
License: https://aka.ms/azureml-sdk-license (https://aka.ms/azureml-sdk-lic
ense)
Location: c:\users\krish\anaconda3\envs\azure_ml_env\lib\site-packages
Requires: azureml-core, azureml-dataset-runtime, azureml-pipeline, azureml-
train-automl-client, azureml-train-core
Required-by:
---
Name: azureml-sdk
Version: 1.49.0
Summary: Used to build and run machine learning workflows upon the     Azur
e Machine Learning service.
Home-page: https://docs.microsoft.com/python/api/overview/azure/ml/?view=az
ure-ml-py (https://docs.microsoft.com/python/api/overview/azure/ml/?view=az
ure-ml-py)
Author: Microsoft Corp
Author-email:
License: https://aka.ms/azureml-sdk-license (https://aka.ms/azureml-sdk-lic
ense)
Location: c:\users\krish\anaconda3\envs\azure_ml_env\lib\site-packages
Requires: azureml-core, azureml-dataset-runtime, azureml-pipeline, azureml-
train-automl-client, azureml-train-core
Required-by:
Note: you may need to restart the kernel to use updated packages.

WARNING: Package(s) not found: ###, To, show, version
```

**STEP 4:** Install Jupyter by using : pip install jupyter
**STEP 5:** Launch jupyter notebook by using command: jupyter notebook

**STEP 6:** Go to azure -> Subscription and check the subscription id you have.

**STEP 7:** Importing the necessary libraries

In [2]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [3]:
```
import azureml
import azure.core
from azureml.core import Workspace,Environment,Experiment,ScriptRunConfig
from azureml.core.compute import AmlCompute, ComputeTarget
from azureml.core.compute_target import ComputeTargetException
from azureml.core import Model
```

**STEP 8:** Specifying the suitable configuration info

In [4]:
```
resource_name = "KD_resource_group"
workspace_name = "KD_demo_workspace"
subscriptionID = "da7f92e5-f637-4517-90fb-493d47170db2" # Please enter your
aml_compute_target = "KD-cluster"                       # ALL SMALL LETTER,
experiment_name= 'demo_expirement_1'
environment_name = 'azure_ml_demo'
```

**STEP 9:** Creating a new workspace if not created

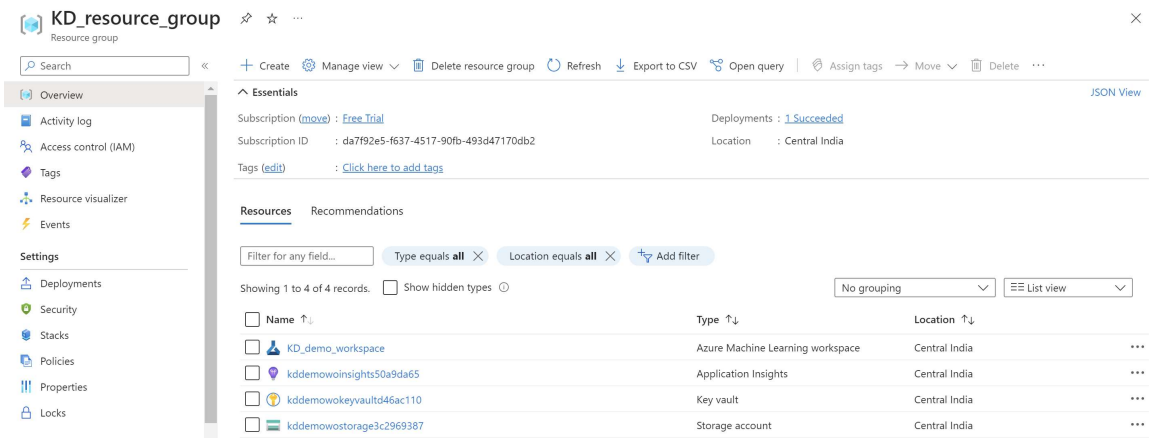
In [5]:
```
# Now create Workspace if no workspace is there
try:
    ws=Workspace.from_config()
    print('Workspace is already exist')
except:
    ws=Workspace.create(workspace_name,
                        resource_group=resource_name,
                        create_resource_group=False,      # If this is made true
                        subscription_id=subscriptionID,
                        location="Central India")
    ws.write_config('.azureml')
```

```
Performing interactive authentication. Please follow the instructions on th
e terminal.

The default web browser has been opened at https://login.microsoftonline.co
m/organizations/oauth2/v2.0/authorize. (https://login.microsoftonline.com/o
rganizations/oauth2/v2.0/authorize.) Please continue the login in the web b
rowser. If no web browser is available or if the web browser fails to open,
use device code flow with `az login --use-device-code`.

Interactive authentication successfully completed.
Deploying StorageAccount with name kddemowostorage3c2969387.
Deploying AppInsights with name kddemowoinsights50a9da65.
Deployed AppInsights with name kddemowoinsights50a9da65. Took 8.69 seconds.
Deploying Workspace with name KD_demo_workspace.
Deployed Workspace with name KD_demo_workspace. Took 37.17 seconds.
```

**STEP 10:** After the above cell got executed, cross check from the Azure portal. Go to Azure -> home -> resource group(under which the workspace is supposed to get created) -> check if the workspace has got created or not.



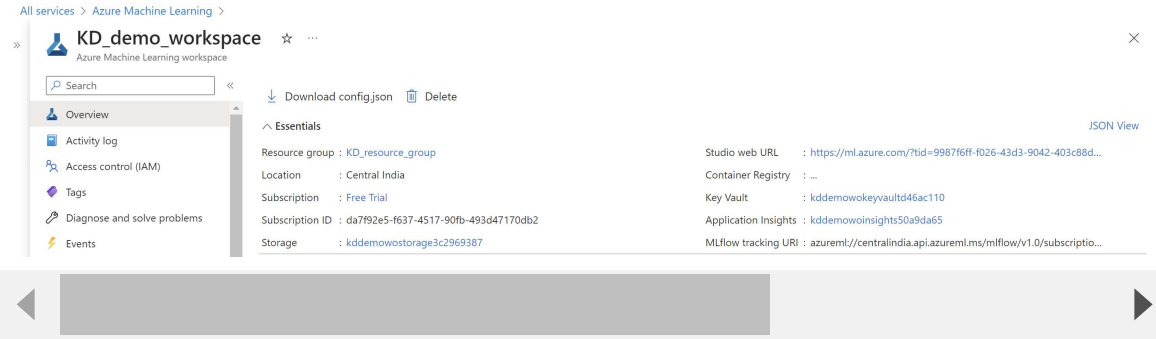

In [5]:
```
ws=Workspace.from_config()  ## To fetch workspace
ws
```

Out[5]:
```
Workspace.create(name='KD_demo_workspace', subscription_id='da7f92e5-f637-4
517-90fb-493d47170db2', resource_group='KD_resource_group')
```

In [6]:
```
print("SDK version:", azureml.core.VERSION)
print(ws.name, ws.resource_group, ws.location, ws.subscription_id, sep = '\n
```

```
SDK version: 1.49.0
KD_demo_workspace
KD_resource_group
centralindia
da7f92e5-f637-4517-90fb-493d47170db2
```

**STEP 11:** Now, we need to click on the "Launch Studio" button or the 'Sudio web url' to got to the Azure Ml Studio.
Link for our case : https://ml.azure.com/?tid=d8533050-79a6-4371-8c5b-ddfadb9be8d2&wsid=/subscriptions/b194183f-1d92-4868-8e02-c46f33bc7030/resourcegroups/KD_resource_group/providers/Microsoft.MachineLearningServi(https://ml.azure.com/?tid=d8533050-79a6-4371-8c5b-ddfadb9be8d2&wsid=/subscriptions/b194183f-1d92-4868-8e02-c46f33bc7030/resourcegroups/KD_resource_group/providers/Microsoft.MachineLearningServi
The below screen must come up if all the things are done prooperly as of now.



**STEP 12:** Check compute tab at the left of the screen and see if there is any compute instance already created or not. If not then we would have to create a new compute instance to run our ML model.The following code will create a compute instance.

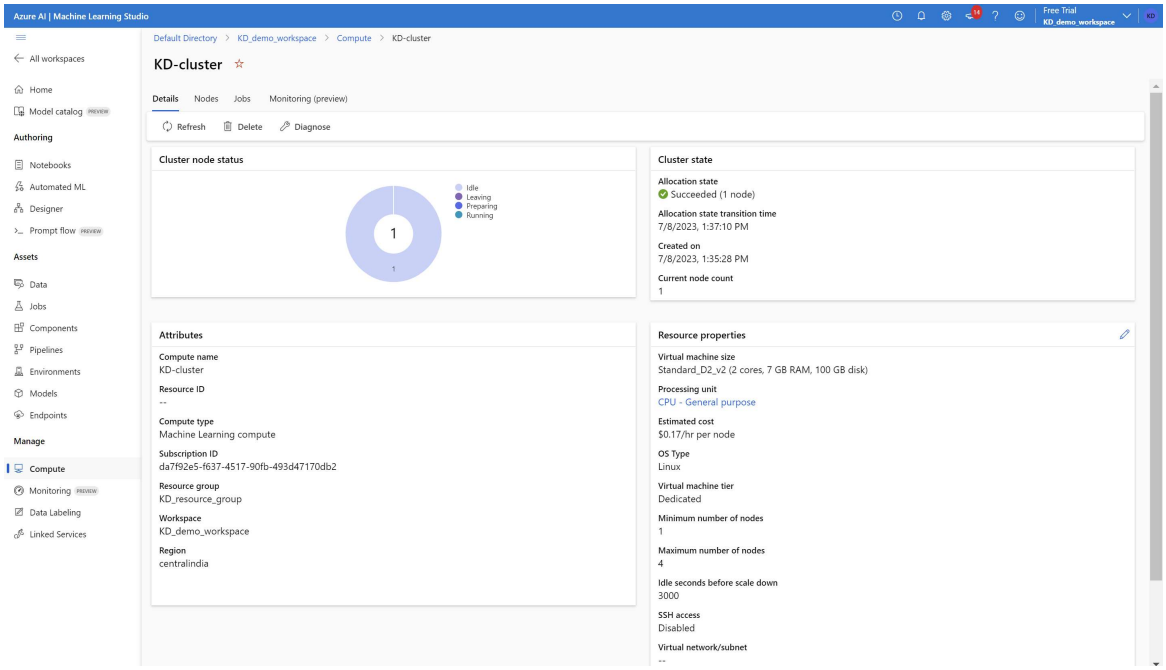
In [8]:
```
# Create Compute Target if it's not created already
try:
    aml_compute = AmlCompute(ws, aml_compute_target)
    print("This Compute Target already exist.")
except ComputeTargetException:
    print("creating new compute target :",aml_compute_target)
    provisioning_config = AmlCompute.provisioning_configuration(vm_size = "S
                                                                 min_nodes =
                                                                 max_nodes =
                                                        idle_seconds_before_scaledown
    aml_compute = ComputeTarget.create(ws, aml_compute_target, provisioning_
    aml_compute.wait_for_completion(show_output=True, min_node_count=None, t

print("Azure Machine Learning Compute attached now")
```

```
creating new compute target : KD-cluster
InProgress.......
SucceededProvisioning operation finished, operation "Succeeded"
Succeeded..............
AmlCompute wait for completion finished

Minimum number of nodes requested have been provisioned
Azure Machine Learning Compute attached now
```

**STEP 13** After successful execution of the command, we should see the compute instance getting attached in the compute tab. path : azure -> home -> resource_group -> KD_resource_group -> demo_azure_ml_workspace -> Launch studio -> compute -> compute clusters.




In [7]:
```
## Checking the compute target that has been craeted
for compute_name in ws.compute_targets:
    compute = ws.compute_targets[compute_name]
    print(compute.name, ":", compute.type)
```

```
KD-cluster : AmlCompute
```

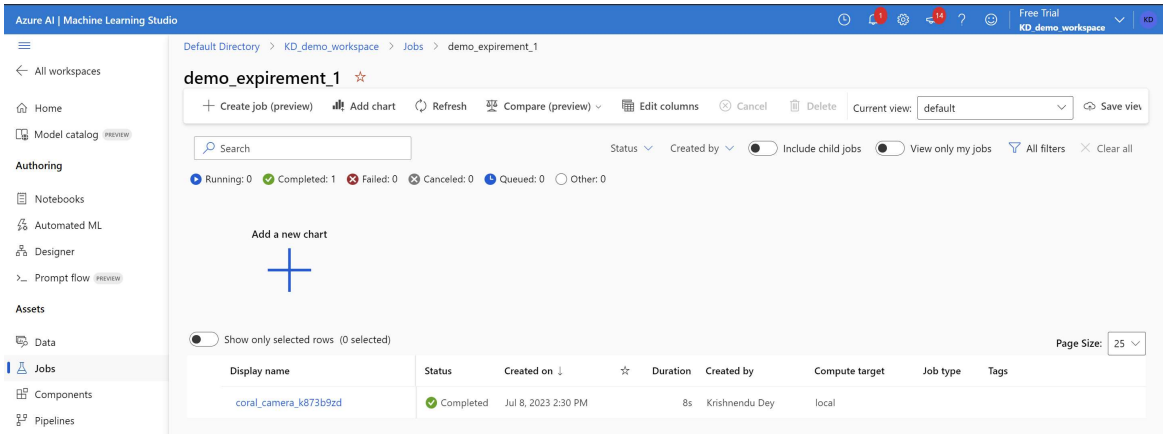
**STEP 14:** Create Experiment using the following command and check if the experiment has been created successfully or not from the path azure -> home -> resource_group -> KD_resource_group -> demo_azure_ml_workspace -> Launch studio -> jobs

In [13]:
```
exp=Experiment(workspace=ws, name=experiment_name,)
run = exp.start_logging()                          # Start logging data fr
run.complete()                                     # Complete the experime
```

In [11]:
```
exp
```

Out[11]:

| Name | Workspace | Report Page | Docs Page |
|---|---|---|---|
| demo_expirement_1 | KD_demo_workspace | Link to Azure Machine Learning studio (https://ml.azure.com/experiments/id/fce22d92-cd13-4618-9429-71a79d6b3f01?wsid=/subscriptions/da7f92e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_resource_group/workspaces/KD_demo_workspace&tid=f026-43d3-9042-403c88da284a) | Link to Documentation (https://docs.microsoft.com/en-us/python/api/azureml-core/azureml.core.experiment.experiment?view=azure-ml-py) |




## Logging

In [39]:
```
import pandas as pd
import seaborn as sns
from sklearn.datasets import load_diabetes


data =  load_diabetes()
X = pd.DataFrame(data= data['data'], columns=data.feature_names)
Y = pd.Series(data['target'])
row_count = (len(X))
```

In [40]:
```
# Log the row count
run.log('observations', row_count)
run.complete()
```

## Retreiving the logs

In [41]:
```
### The logs can be viewed using RunDetails
from azureml.widgets import RunDetails
RunDetails(run).show()
```

```
_UserRunWidget(widget_settings={'childWidgetDisplay': 'popup', 'send_telemetry': False, 'log_level': 'INFO', '…
```

In [43]:
```
import json
# Get logged metrics
metrics = run.get_metrics()
print(json.dumps(metrics, indent=2))
```

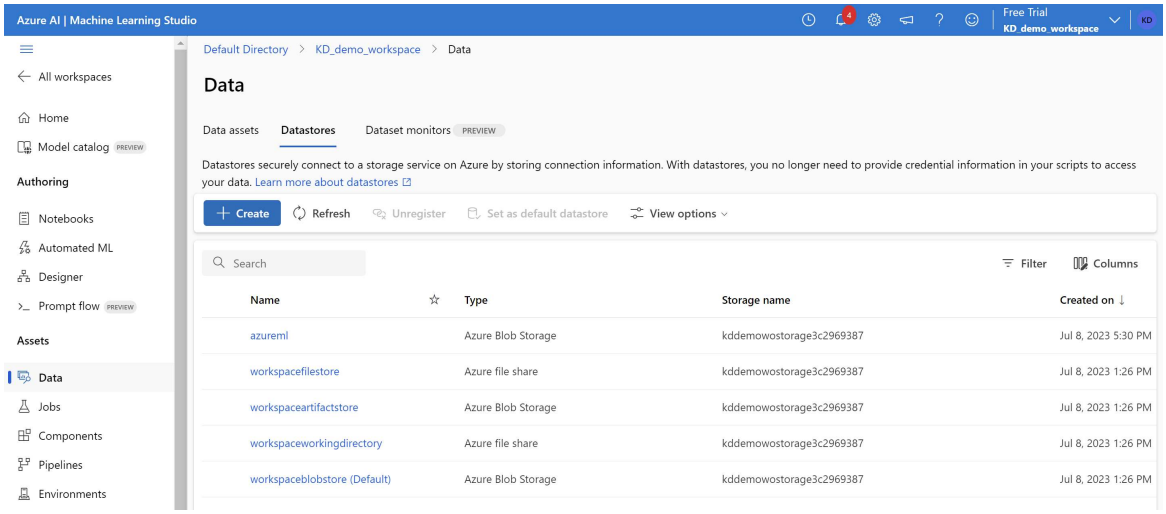

```
{
  "observations": [
    8,
    442
  ]
}
```


**STEP 15**: Working with datastore:

In [72]:
```
### Fetching the default datastores
default_ds=ws.get_default_datastore()
default_ds
```

Out[72]:

```
{
  "name": "workspaceblobstore",
  "container_name": "azureml-blobstore-8f813250-e78c-4309-9f63-32f488470208",
  "account_name": "kddemowostorage3c2969387",
  "protocol": "https",
  "endpoint": "core.windows.net"
}
```

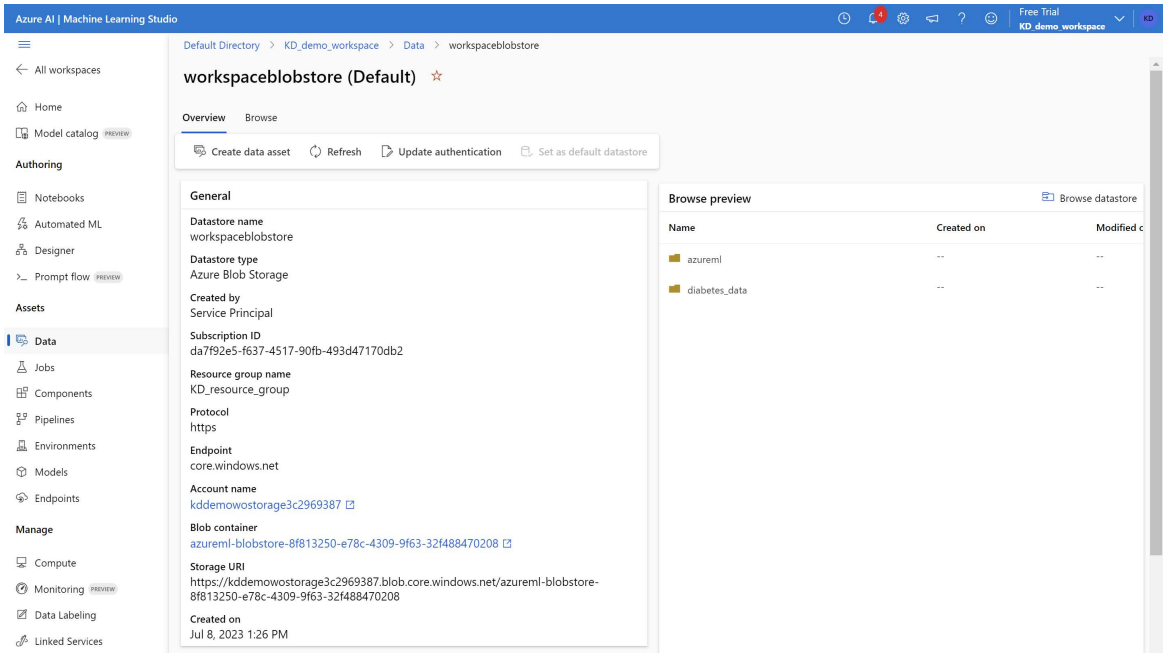



In [73]:
```
### Uploading a file in the default ds
default_ds.upload_files(files=['diabetes.csv'],
                        target_path='diabetes_data/',
                        overwrite=True,
                        show_progress=True)
```

```
"datastore.upload_files" is deprecated after version 1.0.69. Please use "Fi
leDatasetFactory.upload_directory" instead. See Dataset API change notice a
t https://aka.ms/dataset-deprecation. (https://aka.ms/dataset-deprecation.)

Uploading an estimated of 1 files
Uploading diabetes.csv
Uploaded diabetes.csv, 1 files out of an estimated total of 1
Uploaded 1 files
```

Out[73]: $AZUREML_DATAREFERENCE_789addfab01e440b852a7af2a17b187f



In [74]:
```
#### Reading data in the form of dataset from datastore
from azureml.core import Dataset
dataset=Dataset.Tabular.from_delimited_files(path=(default_ds, 'diabetes_dat
df=dataset.to_pandas_dataframe()
df.head(5)
```

Out[74]:

| | Pregnancies | Glucose | BloodPressure | SkinThickness | Insulin | BMI | DiabetesPedigreeFunctio |
|---|---|---|---|---|---|---|---|
| **0** | 6 | 148 | 72 | 35 | 0 | 33.6 | 0.6 |
| **1** | 1 | 85 | 66 | 29 | 0 | 26.6 | 0.3 |
| **2** | 8 | 183 | 64 | 0 | 0 | 23.3 | 0.6 |
| **3** | 1 | 89 | 66 | 23 | 94 | 28.1 | 0.1 |
| **4** | 0 | 137 | 40 | 35 | 168 | 43.1 | 2.2 |

In [75]:
```
### Registering the dataset
try:
    dataset = dataset.register(workspace=ws,
                               name='diabetes dataset',
                               description='diabetes data',
                               create_new_version=True,
                               tags={'format':'csv'})
except Exception as ex :
    print(ex)
```

In [76]:
```
### Fetching all the datafiles
datafiles=Dataset.File.from_files(path=(default_ds, 'diabetes_data/diabetes.
for filepath in datafiles.to_path():
    print(filepath)
```

```
/diabetes.csv
```

In [77]:
```
### Registering datafiles
try:
    datafiles=datafiles.register(workspace=ws,
                               name='diabetes files',
                               description='diabetes files',
                               create_new_version=True,
                               tags={'format':'csv'})
except Exception as ex :
    print(ex)
```

In [83]:
```
# print(dataset)
# print(datafiles)
```

In [82]:
```
## Fetching the diabetes dataset
diabetes_ds=ws.datasets.get('diabetes dataset')
# Alternate Query: Dataset.get_by_name(workspace=ws, name='diabetes dataset'
diabetes_ds
```

Out[82]:

```
{
  "source": [
    "('workspaceblobstore', 'diabetes_data/diabetes.csv')"
  ],
  "definition": [
    "GetDatastoreFiles",
    "ParseDelimited",
    "DropColumns",
    "SetColumnTypes"
  ],
  "registration": {
    "id": "ba38ecfd-9fd7-45b1-830b-888e2b03dd7d",
    "name": "diabetes dataset",
    "version": 1,
    "description": "diabetes data",
    "tags": {
      "format": "csv"
    },
    "workspace": "Workspace.create(name='KD_demo_workspace', subscription_i
d='da7f92e5-f637-4517-90fb-493d47170db2', resource_group='KD_resource_grou
p')"
  }
}
```


In [84]:
```
input_data  = diabetes_ds.as_named_input('dataset')
input_data
```

Out[84]:
```
<azureml.data.dataset_consumption_config.DatasetConsumptionConfig at 0x2788
da8f6a0>
```

**STEP 15**: Creating environment and training model:
In this step we actually specify our required libraries and packages that are to be needed to run the code in the .py file. That environment will be set up in the azure VMs and our code will be executed through the vm in the cloud. To run a script as an experiment, you must define a script configuration that defines the script to be run and the Python environment in which to run it. This is implemented by using a ScriptRunConfig object. This step takes approx 15 mins to execute.

In [8]:
```
# Creating environment : make sure you are in the same directory where mytra
env = Environment.from_conda_specification(name=environment_name,
                                           file_path="./envfile.yml",)
env.register(workspace=ws)                                                  # Re
env
```

Out[8]:

```
{
    "assetId": null,
    "databricks": {
        "eggLibraries": [],
        "jarLibraries": [],
        "mavenLibraries": [],
        "pypiLibraries": [],
        "rcranLibraries": []
    },
    "docker": {
        "arguments": [],
        "baseDockerfile": null,
        "baseImage": "mcr.microsoft.com/azureml/openmpi4.1.0-ubuntu20.04:20
230120.v1",
        "baseImageRegistry": {
            "address": null,
            "password": null,
            "registryIdentity": null,
            "username": null
        },
        "buildContext": null,
        "enabled": false,
        "platform": {
            "architecture": "amd64",
            "os": "Linux"
        },
        "sharedVolumes": true,
        "shmSize": "2g"
    },
    "environmentVariables": {
        "EXAMPLE_ENV_VAR": "EXAMPLE_VALUE"
    },
    "inferencingStackVersion": null,
    "name": "azure_ml_demo",
    "python": {
        "baseCondaEnvironment": null,
        "condaDependencies": {
            "channels": [
                "defaults"
            ],
            "dependencies": [
                "python=3.10.9",
                "anaconda",
                "pip",
                {
                    "pip": [
                        "azureml-sdk",
                        "mlflow",
                        "azureml-mlflow"
                    ]
                }
            ],
            "name": "azure_ml"
        },
        "condaDependenciesFile": null,
        "interpreterPath": "python",
        "userManagedDependencies": false
```

```
    },
    "r": null,
    "spark": {
        "packages": [],
        "precachePackages": true,
        "repositories": []
    },
    "version": null
}
```

Note : Changing hyperparameters and training the model and validating it again by triggering a new job altogether. To use parameters in a script, you must use a library such as ***argparse*** in the mytrain.py file to read the arguments passed to the script and assign them to variables

In [10]:
```
## ScriptRunConfig is used to run the machine learning model from notebook w
config=ScriptRunConfig(source_directory="./",script="mytrain.py",
                       compute_target=aml_compute_target,
                       environment=env,)

execution=exp.submit(config)
execution.wait_for_completion(show_output=True)
```

```
RunId: demo_expirement_1_1688811327_cb3ddc60
Web View: https://ml.azure.com/runs/demo_expirement_1_1688811327_cb3ddc60?w
sid=/subscriptions/da7f92e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_r
esource_group/workspaces/KD_demo_workspace&tid=9987f6ff-f026-43d3-9042-403c
88da284a (https://ml.azure.com/runs/demo_expirement_1_1688811327_cb3ddc60?w
sid=/subscriptions/da7f92e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_r
esource_group/workspaces/KD_demo_workspace&tid=9987f6ff-f026-43d3-9042-403c
88da284a)

Streaming user_logs/std_log.txt
================================

Index(['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness', 'Insuli
n',
       'BMI', 'DiabetesPedigreeFunction', 'Age', 'Outcome'],
      dtype='object')
Accuracy on training set: 1.000
Accuracy on test set: 0.766
Accuracy 0.7662337662337663
0.7662337662337663
Cleaning up all outstanding Run operations, waiting 300.0 seconds
1 items cleaning up...
Cleanup took 0.10429525375366211 seconds

Execution Summary
=================
RunId: demo_expirement_1_1688811327_cb3ddc60
Web View: https://ml.azure.com/runs/demo_expirement_1_1688811327_cb3ddc60?w
sid=/subscriptions/da7f92e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_r
esource_group/workspaces/KD_demo_workspace&tid=9987f6ff-f026-43d3-9042-403c
88da284a (https://ml.azure.com/runs/demo_expirement_1_1688811327_cb3ddc60?w
sid=/subscriptions/da7f92e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_r
esource_group/workspaces/KD_demo_workspace&tid=9987f6ff-f026-43d3-9042-403c
88da284a)
```

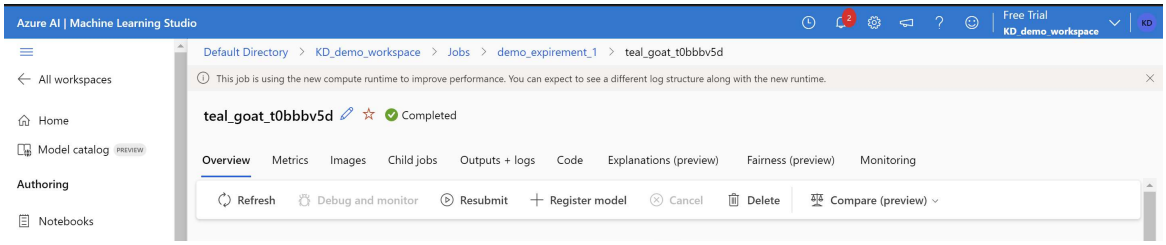
Out[10]:

```
{'runId': 'demo_expirement_1_1688811327_cb3ddc60',
 'target': 'KD-cluster',
 'status': 'Completed',
 'startTimeUtc': '2023-07-08T10:15:43.09724Z',
 'endTimeUtc': '2023-07-08T10:15:57.475597Z',
 'services': {},
 'properties': {'_azureml.ComputeTargetType': 'amlctrain',
  'ContentSnapshotId': '1aac51a8-6f10-4878-9283-68729dbb58ba',
  'ProcessInfoFile': 'azureml-logs/process_info.json',
  'ProcessStatusFile': 'azureml-logs/process_status.json'},
 'inputDatasets': [],
 'outputDatasets': [],
 'runDefinition': {'script': 'mytrain.py',
  'command': '',
  'useAbsolutePath': False,
  'arguments': ['--min_samples_leaf', '5', '--min_samples_split', '7'],
  'sourceDirectoryDataStore': None,
  'framework': 'Python',
  'communicator': 'None',
  'target': 'KD-cluster',
  'dataReferences': {},
  'data': {},
  'outputData': {},
  'datacaches': [],
  'jobName': None,
  'maxRunDurationSeconds': 2592000,
  'nodeCount': 1,
  'instanceTypes': [],
  'priority': None,
  'credentialPassthrough': False,
  'identity': None,
  'environment': {'name': 'azure_ml_demo',
   'version': '1',
   'assetId': 'azureml://locations/centralindia/workspaces/8f813250-e78c-43
09-9f63-32f488470208/environments/azure_ml_demo/versions/1',
   'autoRebuild': True,
   'python': {'interpreterPath': 'python',
    'userManagedDependencies': False,
    'condaDependencies': {'name': 'azure_ml',
     'channels': ['defaults'],
     'dependencies': ['python=3.10.9',
      'anaconda',
      'pip',
      {'pip': ['azureml-sdk', 'mlflow', 'azureml-mlflow']}]},
    'baseCondaEnvironment': None},
   'environmentVariables': {'EXAMPLE_ENV_VAR': 'EXAMPLE_VALUE'},
   'docker': {'baseImage': 'mcr.microsoft.com/azureml/openmpi4.1.0-ubuntu2
0.04:20230120.v1',
    'platform': {'os': 'Linux', 'architecture': 'amd64'},
    'baseDockerfile': None,
    'baseImageRegistry': {'address': None, 'username': None, 'password': No
ne},
    'enabled': False,
    'arguments': []},
   'spark': {'repositories': [], 'packages': [], 'precachePackages': True},
   'inferencingStackVersion': None},
  'history': {'outputCollection': True,
```

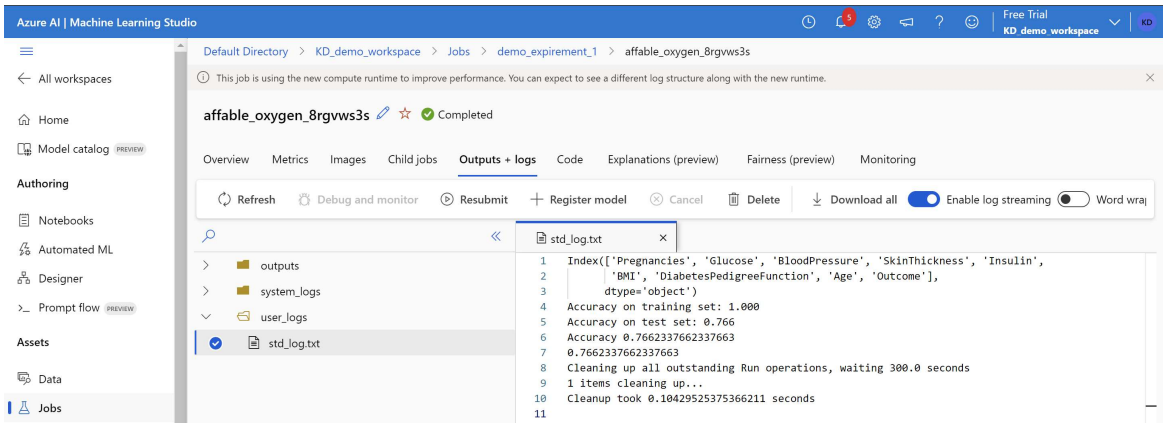
```
   'directoriesToWatch': ['logs'],
   'enableMLflowTracking': True,
   'snapshotProject': True},
  'spark': {'configuration': {'spark.app.name': 'Azure ML Experiment',
    'spark.yarn.maxAppAttempts': '1'}},
  'parallelTask': {'maxRetriesPerWorker': 0,
   'workerCountPerNode': 1,
   'terminalExitCodes': None,
   'configuration': {}},
  'amlCompute': {'name': None,
   'vmSize': None,
   'retainCluster': False,
   'clusterMaxNodeCount': None},
  'aiSuperComputer': {'instanceType': 'D2',
   'imageVersion': None,
   'location': None,
   'aiSuperComputerStorageData': None,
   'interactive': False,
   'scalePolicy': None,
   'virtualClusterArmId': None,
   'tensorboardLogDirectory': None,
   'sshPublicKey': None,
   'sshPublicKeys': None,
   'enableAzmlInt': True,
   'priority': 'Medium',
   'slaTier': 'Standard',
   'userAlias': None},
  'kubernetesCompute': {'instanceType': None},
  'tensorflow': {'workerCount': 1, 'parameterServerCount': 1},
  'mpi': {'processCountPerNode': 1},
  'pyTorch': {'communicationBackend': 'nccl', 'processCount': None},
  'hdi': {'yarnDeployMode': 'Cluster'},
  'containerInstance': {'region': None, 'cpuCores': 2.0, 'memoryGb': 3.5},
  'exposedPorts': None,
  'docker': {'useDocker': False,
   'sharedVolumes': True,
   'shmSize': '2g',
   'arguments': []},
  'cmk8sCompute': {'configuration': {}},
  'commandReturnCodeConfig': {'returnCode': 'Zero',
   'successfulReturnCodes': []},
  'environmentVariables': {},
  'applicationEndpoints': {},
  'parameters': []},
 'logFiles': {'user_logs/std_log.txt': 'https://kddemowostorage3c2969387.bl
ob.core.windows.net/azureml/ExperimentRun/dcid.demo_expirement_1_1688811327
_cb3ddc60/user_logs/std_log.txt?sv=2019-07-07&sr=b&sig=IqvdwYW4%2B1BErti6J%
2FP2sd84l4L7N6lgGGg0XKzAYYg%3D&skoid=519c9b80-fd48-42e8-a412-61c41ef4a583&s
ktid=9987f6ff-f026-43d3-9042-403c88da284a&skt=2023-07-08T09%3A32%3A06Z&ske=
2023-07-09T17%3A42%3A06Z&sks=b&skv=2019-07-07&st=2023-07-08T10%3A06%3A00Z&s
e=2023-07-08T18%3A16%3A00Z&sp=r',
  'system_logs/cs_capability/cs-capability.log': 'https://kddemowostorage3c
2969387.blob.core.windows.net/azureml/ExperimentRun/dcid.demo_expirement_1_
1688811327_cb3ddc60/system_logs/cs_capability/cs-capability.log?sv=2019-07-
07&sr=b&sig=sShAt3wxIL9jo0rUbHMXhSDnu%2FkFTUGnhJaIx58N2zs%3D&skoid=519c9b80
-fd48-42e8-a412-61c41ef4a583&sktid=9987f6ff-f026-43d3-9042-403c88da284a&skt
=2023-07-08T09%3A32%3A06Z&ske=2023-07-09T17%3A42%3A06Z&sks=b&skv=2019-07-07
```

```
&st=2023-07-08T10%3A06%3A01Z&se=2023-07-08T18%3A16%3A01Z&sp=r',
  'system_logs/hosttools_capability/hosttools-capability.log': 'https://kdd
emowostorage3c2969387.blob.core.windows.net/azureml/ExperimentRun/dcid.demo
_expirement_1_1688811327_cb3ddc60/system_logs/hosttools_capability/hosttool
s-capability.log?sv=2019-07-07&sr=b&sig=ZVGoPjmfH3VGAu9xtK4QRuawMH0CG8gNWNu
okaERGRE%3D&skoid=519c9b80-fd48-42e8-a412-61c41ef4a583&sktid=9987f6ff-f026-
43d3-9042-403c88da284a&skt=2023-07-08T09%3A32%3A06Z&ske=2023-07-09T17%3A42%
3A06Z&sks=b&skv=2019-07-07&st=2023-07-08T10%3A06%3A01Z&se=2023-07-08T18%3A1
6%3A01Z&sp=r',
  'system_logs/lifecycler/execution-wrapper.log': 'https://kddemowostorage3
c2969387.blob.core.windows.net/azureml/ExperimentRun/dcid.demo_expirement_1
_1688811327_cb3ddc60/system_logs/lifecycler/execution-wrapper.log?sv=2019-0
7-07&sr=b&sig=4EY9pgFoALfDmIU%2Blu%2FewewfUTUKsHysIoMOTAUX6lg%3D&skoid=519c
9b80-fd48-42e8-a412-61c41ef4a583&sktid=9987f6ff-f026-43d3-9042-403c88da284a
&skt=2023-07-08T09%3A32%3A06Z&ske=2023-07-09T17%3A42%3A06Z&sks=b&skv=2019-0
7-07&st=2023-07-08T10%3A06%3A01Z&se=2023-07-08T18%3A16%3A01Z&sp=r',
  'system_logs/lifecycler/lifecycler.log': 'https://kddemowostorage3c296938
7.blob.core.windows.net/azureml/ExperimentRun/dcid.demo_expirement_1_168881
1327_cb3ddc60/system_logs/lifecycler/lifecycler.log?sv=2019-07-07&sr=b&sig=
JV2PedtG%2FrCz4Tg315de61ceitDEY%2FoieO64C5wXLSY%3D&skoid=519c9b80-fd48-42e8
-a412-61c41ef4a583&sktid=9987f6ff-f026-43d3-9042-403c88da284a&skt=2023-07-0
8T09%3A32%3A06Z&ske=2023-07-09T17%3A42%3A06Z&sks=b&skv=2019-07-07&st=2023-0
7-08T10%3A06%3A01Z&se=2023-07-08T18%3A16%3A01Z&sp=r',
  'system_logs/metrics_capability/metrics-capability.log': 'https://kddemow
ostorage3c2969387.blob.core.windows.net/azureml/ExperimentRun/dcid.demo_exp
irement_1_1688811327_cb3ddc60/system_logs/metrics_capability/metrics-capabi
lity.log?sv=2019-07-07&sr=b&sig=Ojen4RTXPloeYkT0aC%2BlkxUvNzi43ok1E%2BTBeJq
DH3U%3D&skoid=519c9b80-fd48-42e8-a412-61c41ef4a583&sktid=9987f6ff-f026-43d3
-9042-403c88da284a&skt=2023-07-08T09%3A32%3A06Z&ske=2023-07-09T17%3A42%3A06
Z&sks=b&skv=2019-07-07&st=2023-07-08T10%3A06%3A01Z&se=2023-07-08T18%3A16%3A
01Z&sp=r',
  'system_logs/snapshot_capability/snapshot-capability.log': 'https://kddem
owostorage3c2969387.blob.core.windows.net/azureml/ExperimentRun/dcid.demo_e
xpirement_1_1688811327_cb3ddc60/system_logs/snapshot_capability/snapshot-ca
pability.log?sv=2019-07-07&sr=b&sig=enxAKpFOM7nWAjI%2BxdfNnHjHZzPJkz6HYO6dC
SlPzhw%3D&skoid=519c9b80-fd48-42e8-a412-61c41ef4a583&sktid=9987f6ff-f026-43
d3-9042-403c88da284a&skt=2023-07-08T09%3A32%3A06Z&ske=2023-07-09T17%3A42%3A
06Z&sks=b&skv=2019-07-07&st=2023-07-08T10%3A06%3A01Z&se=2023-07-08T18%3A16%
3A01Z&sp=r'},
 'submittedBy': 'Krishnendu Dey'}
```


When the code gets successfully executed, then go to jobs and check if the job id has completed or not from azure.




**STEP 16:** To check how the model performs, go to outputs and logs tab.




In [15]:
```
execution
```

Out[15]:

| Experiment | Id | Type | Status | Details Page | Docs Page |
|---|---|---|---|---|---|
| demo_expirement | demo_expirement_1_1698811327_cb3dd60 | Command | Completed | Link to Azure Machine Learning studio (https://ml.azure.com/runs/demo_expirement_1_1698811327_cb3dd60?wsid=/subscriptions/1a3792e5-f637-4517-90fb-493d47170db2/resourcegroups/KD_demo_rg/workspaces/KD_demo_workspace&tid=f026-43d3-9042-403c88da284a) | Link to Documentation (https://docs.microsoft.com/python/api/azureml-core/azureml.core.experiment.experiment?view=azure-ml-py) |

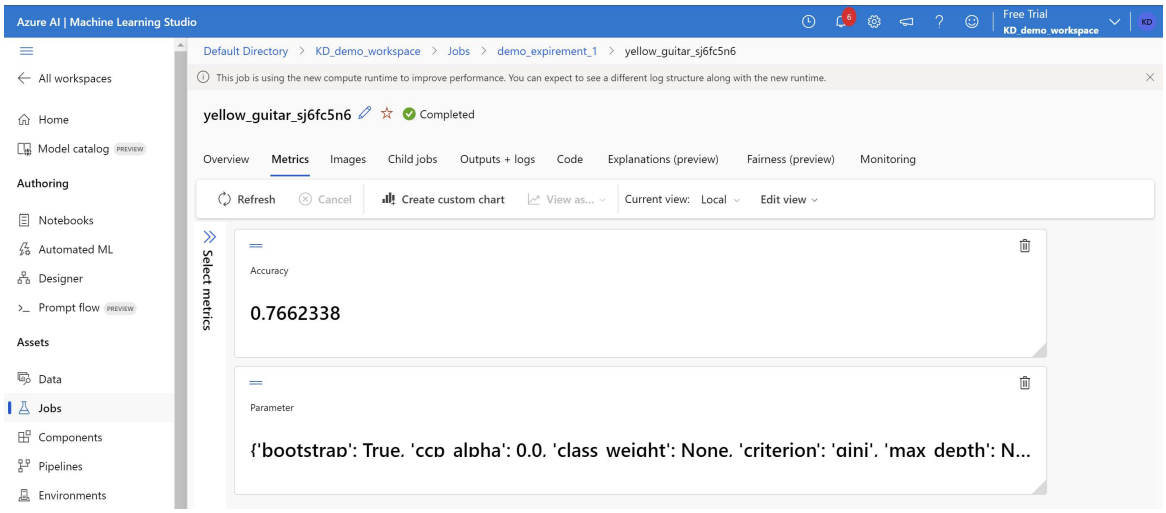
**STEP 17:** Now the above steps would not give us anything getting displayed on the Metrics tab for the job. To populate the results of the population matrics on the tab we need to make certain modification to the code.The code with specific changes can be found in the mytrain_log.py file.

In [89]:
```
config=ScriptRunConfig(source_directory="./",
                       script="train.py",
                       compute_target=aml_compute_target,
                       environment=env,
                       arguments=['--min_samples_leaf',5,
                                  '--min_samples_split',7,
                                  '--input_data',input_data,])
execution=exp.submit(config)
```

In [90]:
```
execution
```

Out[90]:

| Experiment | Id | Type | Status | Details Page | Docs Page |
|---|---|---|---|---|---|
| demo_expirement | demo_expirement_1_1688823904_62bccc2e | Starting | | Link to Azure Machine Learning studio (https://ml.azure.com/runs/demo_expirement_1_1688823904_62bccc2e?wsid=/subscriptions/[illegible]/resourcegroups/KD_demo_workspace/providers/Microsoft.MachineLearningServices/workspaces/KD_demo_workspace) | Link to Documentation (https://docs.microsoft.com/en-us/python/api/azureml-core/azureml.core.experiment.experiment?view=azure-ml-py) |



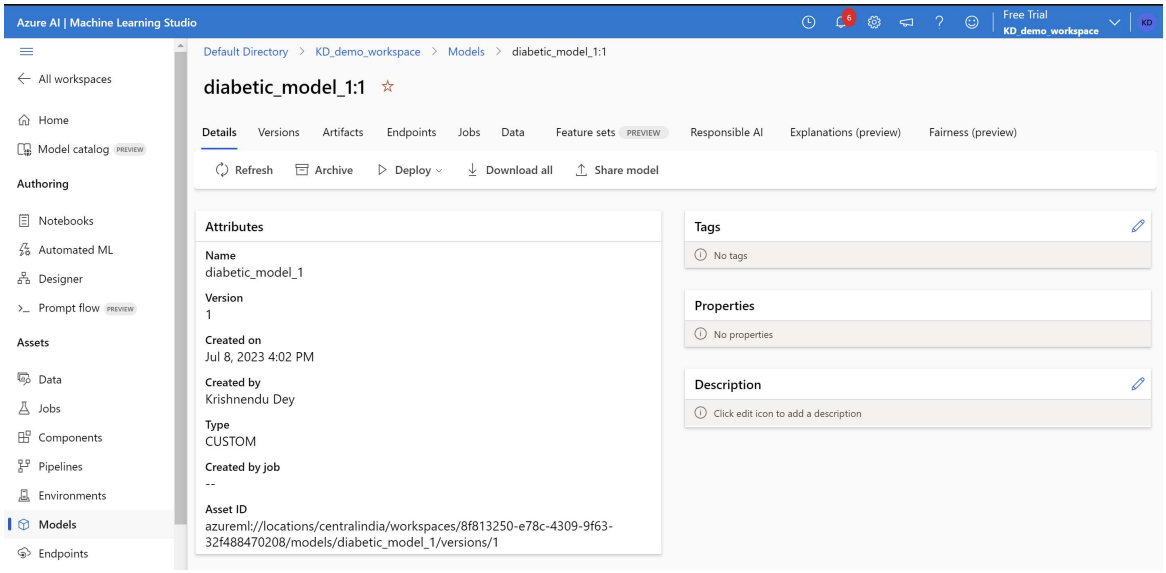

**STEP 19:** So far the model has been built in the backend and the training and testing is done using azure VM. But if we want to see the model from the UI , we won't be able to coz the model would not be there in the models option of the Azure ML Studio untill we register it for further usage. Below code demonstrates how the model registration is done.

In [69]:
```
#Register model in workspace
model_name = "diabetic_model_1"
model = Model.register(ws,
                       model_path="./outputs/diabeticmodel.pkl",
                       model_name= model_name,
                       model_framework=Model.Framework.SCIKITLEARN,
                       description='A classification model',
                       tags={'data-format': 'CSV'},)
```

```
Registering model diabetic_model_1
```

In [70]:
```
model
```

Out[70]:
```
Model(workspace=Workspace.create(name='KD_demo_workspace', subscription_id
='da7f92e5-f637-4517-90fb-493d47170db2', resource_group='KD_resource_grou
p'), name=diabetic_model_1, id=diabetic_model_1:2, version=2, tags={'data-f
ormat': 'CSV'}, properties={})
```




In [71]:
```
## Retrieving registered model
for model in Model.list(ws):
    print("Model Name : ", model.name,"|", "version :", model.version)
```

```
Model Name :  diabetic_model_1 | version : 2
Model Name :  diabetic_model_1 | version : 1
```

In [ ]:
```
### An Alternate way of deploying model
# run.register_model( model_name='classification_model',
#                     model_path='outputs/diabeticmodel.pkl',             #
#                     description='A classification model',
#                     tags={'data-format': 'CSV'},
#                     model_framework=Model.Framework.SCIKITLEARN,
#                     model_framework_version='0.20.3')
```

**STEP 20- Deploy Registered Model:**

***STEP 20.1: Getting the Registered ML Model***

In [26]:
```
## Getting the Registered ML Model
model = Model(ws,model_name)            ## this is how a perticular model is
model
```

Out[26]:
```
Model(workspace=Workspace.create(name='KD_demo_workspace', subscription_id
='da7f92e5-f637-4517-90fb-493d47170db2', resource_group='KD_resource_grou
p'), name=diabetic_model_1, id=diabetic_model_1:1, version=1, tags={}, prop
erties={})
```

***STEP 20.2 : Define an inference configuration***

The model will be deployed as a service that consist of:

- A script to load the model and return predictions for submitted data.
- An environment in which the script will be run.

***STEP 20.2.1 : Create an entry script***

Create the entry script (sometimes referred to as the scoring script) for the service as a Python (.py) file. It must include two functions:

- init(): Called when the service is initialized.
- run(raw_data): Called when new data is submitted to the service. Typically, you use the init function to load the model from the model registry, and use the run function to generate predictions from the input data. The following example script of score.py file shows this pattern:

```
                import json
                import joblib
                import numpy as np
                import os
                def init():
                    global model
                    # Get the path to the registered model file an
d load it
                    model_path = os.path.join(os.getenv('AZUREML_M
ODEL_DIR'), 'model.pkl')
                    model = joblib.load(model_path)
```

***STEP 20.2.2: Create an environment***

Your service requires a Python environment in which to run the entry script, which you can define by creating an Environment that contains the required packages. This environment is required for inferencing the reesult of the ml model:

In [57]:
```
## Creating Inference Environment for the model prediction
from azureml.core.model import InferenceConfig
from azureml.core.conda_dependencies import CondaDependencies

myenv=Environment(name="demo-env")
conda_packages = ['numpy']
pip_packages = ['azureml-sdk','azureml-defaults','scikit-learn','pandas', 'n
mycondaenv = CondaDependencies.create(conda_packages=conda_packages,
                                      pip_packages=pip_packages,
                                      python_version='3.10.9')
myenv.python.conda_dependencies=mycondaenv
myenv.register(workspace=ws)
```

Out[57]:

```
{
    "assetId": "azureml://locations/centralindia/workspaces/8f813250-e78c-4
309-9f63-32f488470208/environments/demo-env/versions/4",
    "databricks": {
        "eggLibraries": [],
        "jarLibraries": [],
        "mavenLibraries": [],
        "pypiLibraries": [],
        "rcranLibraries": []
    },
    "docker": {
        "arguments": [],
        "baseDockerfile": null,
        "baseImage": "mcr.microsoft.com/azureml/openmpi4.1.0-ubuntu20.04:20
230120.v1",
        "baseImageRegistry": {
            "address": null,
            "password": null,
            "registryIdentity": null,
            "username": null
        },
        "buildContext": null,
        "enabled": false,
        "platform": {
            "architecture": "amd64",
            "os": "Linux"
        },
        "sharedVolumes": true,
        "shmSize": null
    },
    "environmentVariables": {
        "EXAMPLE_ENV_VAR": "EXAMPLE_VALUE"
    },
    "inferencingStackVersion": null,
    "name": "demo-env",
    "python": {
        "baseCondaEnvironment": null,
        "condaDependencies": {
            "channels": [
                "anaconda",
                "conda-forge"
            ],
            "dependencies": [
                "python=3.10.9",
                {
                    "pip": [
                        "azureml-sdk~=1.49.0",
                        "azureml-defaults~=1.49.0",
                        "scikit-learn",
                        "pandas",
                        "numpy",
                        "os"
                    ]
                },
                "numpy"
            ],
            "name": "project_environment"
```

```
        },
        "condaDependenciesFile": null,
        "interpreterPath": "python",
        "userManagedDependencies": false
    },
    "r": null,
    "spark": {
        "packages": [],
        "precachePackages": true,
        "repositories": []
    },
    "version": "4"
}
```

In [58]:
```
# Combine the script and environment in an InferenceConfig
inference_config = InferenceConfig(entry_script='score.py',
                                   source_directory='.',
                                   environment=myenv)
inference_config
```

Out[58]:
```
InferenceConfig(entry_script=score.py, runtime=None, conda_file=None, extra
_docker_file_steps=None, source_directory=C:\Users\krish\OneDrive\Desktop\S
tudy\Azure MLOPs\DP 100 Certifications, enable_gpu=None, base_image=None, b
ase_image_registry=<azureml.core.container_registry.ContainerRegistry objec
t at 0x0000027887695660>)
```

***STEP 20.3 : Define a deployment configuration***

Now that you have the entry script and environment, you need to configure the compute to which the service will be deployed. If you are deploying to an AKS cluster, you must create the cluster and a compute target for it before deploying:

In [59]:
```
### Specifying the machines of what configuration would be required to make
from azureml.core.webservice import AciWebservice
aciconfig = AciWebservice.deploy_configuration(cpu_cores=1,memory_gb=2)
aciconfig
```

Out[59]:
```
<azureml.core.webservice.aci.AciServiceDeploymentConfiguration at 0x27885b5
8670>
```

***STEP 20.4: Deployment***

In [91]:
```
%%time
## Deploying model as a service for real time predictions
service = Model.deploy(ws,"model-endpoint",                                #This i
                           models=[model],
                           inference_config=inference_config,
                           deployment_config=aciconfig,
                           #deployment_target=predenv,
                           overwrite=True)
service.wait_for_deployment(show_output=True)
url = service.scoring_uri
print(url)
```

```
Tips: You can try get_logs(): https://aka.ms/debugimage#dockerlog (https://
aka.ms/debugimage#dockerlog) or local deployment: https://aka.ms/debugimage
#debug-locally (https://aka.ms/debugimage#debug-locally) to debug if deploy
ment takes longer than 10 minutes.
Running
2023-07-08 19:18:25+05:30 Creating Container Registry if not exists.
2023-07-08 19:18:25+05:30 Registering the environment.
2023-07-08 19:18:25+05:30 Building image.
Failed

Service deployment polling reached non-successful terminal state, current s
ervice state: Unhealthy
Operation ID: 2c6d382b-6cf4-4289-9ed2-aeb40cb36fd6
More information can be found here:
Error:
{
  "code": "EnvironmentBuildFailed",
  "statusCode": 400,
  "message": "Failed building the Environment. You can try debugging locall
y first. Please refer to https://aka.ms/debugimage#debug-locally (https://a
ka.ms/debugimage#debug-locally) for more information."
}
```

```
---------------------------------------------------------------------------
WebserviceException                       Traceback (most recent call last)
File <timed exec>:8

File c:\Users\krish\anaconda3\envs\azure_ml_env\lib\site-packages\azureml\core\webservice\webservice.py:918, in Webservice.wait_for_deployment(self, show_output, timeout_sec)
    915         if not logs_response:
    916             logs_response = 'Current sub-operation type not known, more logs unavailable.'
--> 918         raise WebserviceException('Service deployment polling reached non-successful terminal state, current '
    919                                   'service state: {}\n'
    920                                   'Operation ID: {}\n'
    921                                   '{}\n'
    922                                   'Error:\n'
    923                                   '{}'.format(self.state, self._operation_endpoint.split('/')[-1],
    924                                               logs_response, format_error_response), logger=module_logger)
    925     print('{} service creation operation finished, operation "{}"'.format(self._webservice_type,
    926                                                                           operation_state))
    927 except WebserviceException as e:

WebserviceException: WebserviceException:
        Message: Service deployment polling reached non-successful terminal state, current service state: Unhealthy
Operation ID: 2c6d382b-6cf4-4289-9ed2-aeb40cb36fd6
More information can be found here:
Error:
{
  "code": "EnvironmentBuildFailed",
  "statusCode": 400,
  "message": "Failed building the Environment. You can try debugging locally first. Please refer to https://aka.ms/debugimage#debug-locally (https://aka.ms/debugimage#debug-locally) for more information."
}
        InnerException None
        ErrorResponse
{
    "error": {
        "message": "Service deployment polling reached non-successful terminal state, current service state: Unhealthy\nOperation ID: 2c6d382b-6cf4-4289-9ed2-aeb40cb36fd6\nMore information can be found here: \nError:\n{\n  \"code\": \"EnvironmentBuildFailed\",\n  \"statusCode\": 400,\n  \"message\": \"Failed building the Environment. You can try debugging locally first. Please refer to https://aka.ms/debugimage#debug-locally (https://aka.ms/debugimage#debug-locally) for more information.\"\n}"
    }
}
```

In [61]:
```
print(service.get_logs())
```

```
Error in environment creation, more details may be found here: https://kddemowostorage3c2969387.blob.core.windows.net/azureml/ImageLogs/e0e91736-ed72-4e35-b7a0-b3da81099b90/build.log (https://kddemowostorage3c2969387.blob.core.windows.net/azureml/ImageLogs/e0e91736-ed72-4e35-b7a0-b3da81099b90/build.log)
```

In [55]:
```
## Fetching the deployed service and examining it's health
model_endpoint_name = "model-endpoint"
service = AciWebservice(name = model_endpoint_name, workspace=ws)
print(service.state)
```

```
Unhealthy
```

After Deployment is done, go to endpoint to see the serivce that has been deployed.

image.png

image.png

In [ ]:
```
## to get the logs if the service health is not "Healthy"
# print(service.get_logs())
```

**STEP 21: Testing the Deployed Model**

In [63]:
```
# Prepare your test data
import pandas as pd
import json
data = pd.read_csv('test.csv')
xt = data.values.tolist()
test = json.dumps({"data":xt})
```

In [64]:
```
test[:59]
```

Out[64]:
```
'{"data": [[6.0, 148.0, 72.0, 35.0, 0.0, 33.6, 0.627, 50.0],'
```

In [ ]:
```
# Fetching the deployed model
from azureml.core import Webservice
service = Webservice(workspace=ws, name="demo-model")
print(service.scoring_uri)
print(service.swagger_uri)
```

```
http://905ed832-9412-4764-886c-7b84317f6e2a.centralindia.azurecontainer.io/score (http://905ed832-9412-4764-886c-7b84317f6e2a.centralindia.azurecontainer.io/score)
http://905ed832-9412-4764-886c-7b84317f6e2a.centralindia.azurecontainer.io/swagger.json (http://905ed832-9412-4764-886c-7b84317f6e2a.centralindia.azurecontainer.io/swagger.json)
```

In [ ]:
```
# Running the predictions
prediction = service.run(input_data=test)
prediction[:10]
```

Out[56]:
```
[1, 0, 0, 0, 1, 0, 1, 0, 1, 1]
```

In [ ]:
```
## Real-Time predictions using REST call
import requests
headers = {'content-Type':'application/json'}

response = requests.post(service.scoring_uri, test, headers=headers)
response.text
```

Out[57]:
```
'[1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1,
1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1,
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1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0]'
```

**NOTE: Local Deployment in Docker**

In [68]:
```
## It will work when Docker is installed in the PC
from azureml.core.webservice import LocalWebservice
deployment_config = LocalWebservice.deploy_configuration(port=5002)
local_service = Model.deploy(ws,
                        'test-deployment-1',
                        [model],
                        inference_config=inference_config,
                        deployment_config=deployment_config)
```

```
Failed to create Docker client. Is Docker running/installed?
When you deploy locally, we download a dockerfile
execute docker build on it, and docker run the built container for you
Error: Error while fetching server API version: (2, 'CreateFile', 'The
system cannot find the file specified.')


---------------------------------------------------------------------
-----
error                                     Traceback (most recent call
last)
File c:\Users\krish\anaconda3\envs\azure_ml_env\lib\site-packages\dock
er\api\client.py:214, in APIClient._retrieve_server_version(self)
    213 try:
--> 214     return self.version(api_version=False)["ApiVersion"]
    215 except KeyError:

File c:\Users\krish\anaconda3\envs\azure_ml_env\lib\site-packages\dock
er\api\daemon.py:181, in DaemonApiMixin.version(self, api_version)
    180 url = self._url("/version", versioned_api=api_version)
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

**STEP 22:Authentication**

In production, you will likely want to restrict access to your services by applying authentication. There are two kinds of authentication you can use:

- ***Key:*** Requests are authenticated by specifying the key associated with the service.
- ***Token:*** Requests are authenticated by providing a JSON Web Token (JWT).

By default, authentication is disabled for ACI services, and set to key-based authentication for AKS services (for which primary and secondary keys are automatically generated). You can optionally configure an AKS service to use token-based authentication (which is not supported for ACI services).

Assuming you have an authenticated session established with the workspace, you can retrieve the keys for a service by using the get_keys method of the WebService object associated with the service:

In [ ]:
```
# primary_key, secondary_key = service.get_keys()
# print(primary_key)
```

In [ ]:
```
# Set additional parameter key_or_token to make predictions from the deploye
import requests
headers = { "Content-Type":"application/json",
            "Authorization":"Bearer " + key_or_token }

response = requests.post(service.scoring_uri, test, headers=headers)
response.text
```