

AZURE MLOPS DEMO

~ Agile Summit 2022 ~

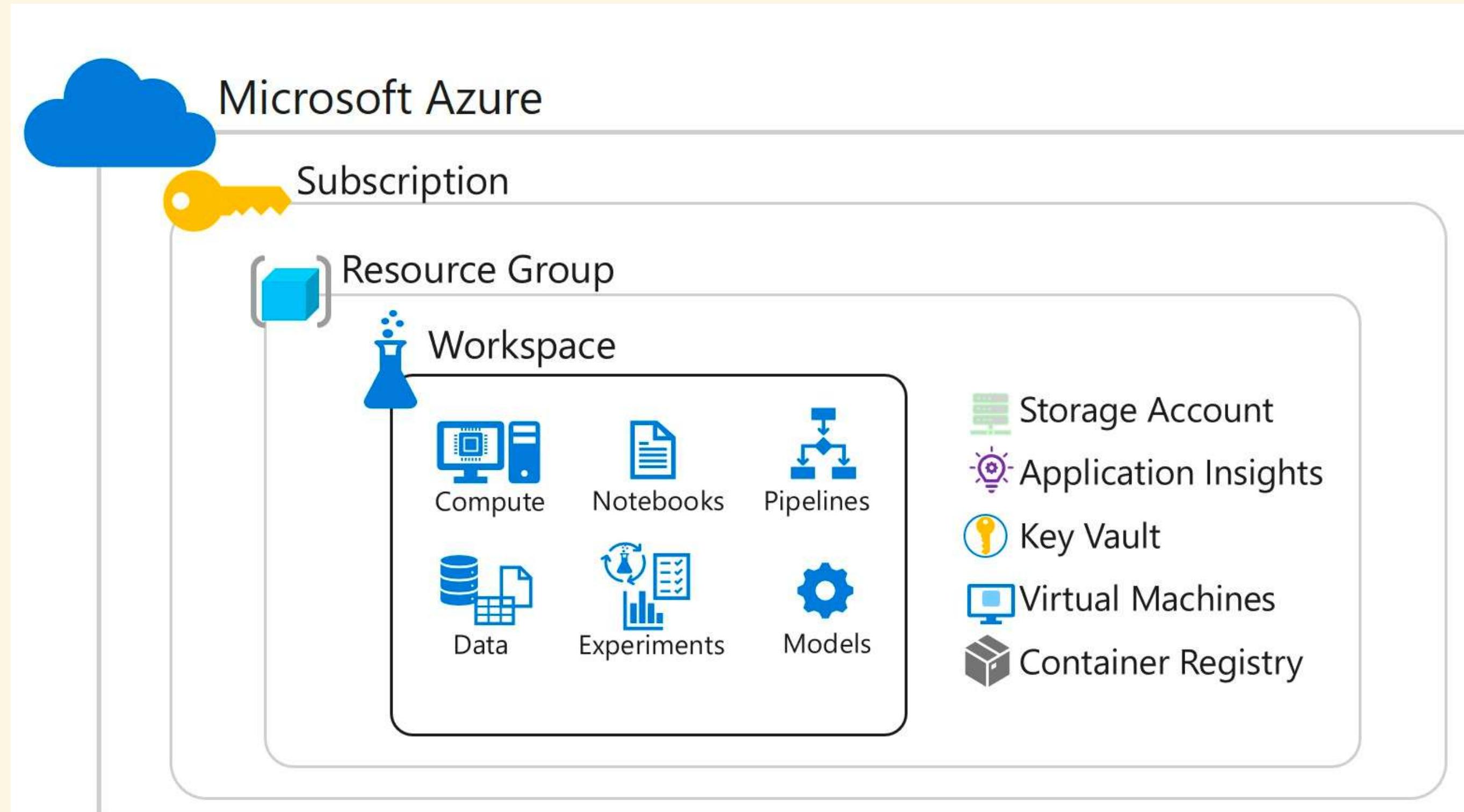
Kuo-Chun Su

AGENDA

- Azure Machine Learning Python SDK v2 (preview)
- Demo 1 : On-Premises Development (Conda + Poetry)
- Demo 2 : Azure Machine Learning Python SDK v2 (Jupyter Notebook)
- Demo 3 : Azure DevOps Pipeline (Classic Editor + Empty Job Template)

INTRODUCTION

AZURE MACHINE LEARNING



USAGE SCENARIOS

- Machine Learning Studio Web UI
- Azure Machine Learning Python SDK
- Azure CLI + ML Extension

```
$schema: https://azurermschemas.azureedge.net/latest/commandJob.schema.json
code:
  local_path: src
command: >
  python main.py
  --iris.csv (inputs:iris)
inputs:
  iris:
    data:
      path: https://azuremlexamples.blob.core.windows.net/datasets/iris.csv
      mode: mount
environment:
  docker:
    image: mcr.microsoft.com/azureml/openmpi3.1.2-ubuntu18.04
    conda_file: file:environment.yml
compute:
  target: azureml:cpu-cluster
```

Microsoft Azure Machine Learning Studio

Microsoft > automl_ws > Automated ML

Automated ML

Let Automated ML train and find the best model based on your data without writing a single line of code. [Learn more about Automated ML](#)

+ New Automated ML job Refresh

No recent Automated ML jobs to display.

Click "New Automated ML job" to create your first job

[Learn more about creating Automated ML jobs](#)

Documentation

View all documentation

Concept: What is Automated ML?

Tutorial: Create your first classification model with Automated ML

Blog: Build more accurate forecasts with new capabilities in Automated ML

```
from azureml.core import Workspace
from azureml.core.compute import ComputeTarget, AmlCompute
from azureml.core.compute_target import ComputeTargetException
from constant import Constant
ws = Workspace.from_config() # This automatically looks for a directory .azureml

# Choose a name for your CPU cluster
cpu_cluster_name = Constant.CPU_CLUSTER_NAME

# Verify that the cluster does not exist already
try:
    cpu_cluster = ComputeTarget(workspace=ws, name=cpu_cluster_name)
    print('Found existing cluster, use it!')
except ComputeTargetException:
    compute_config = AmlCompute.provisioning_configuration(vm_size='STANDARD_D2_V2',
                                                          max_nodes=4,
                                                          idle_seconds_before_scaledown=2400)
    cpu_cluster = ComputeTarget.create(ws, cpu_cluster_name, compute_config)
    print('Create new compute cluster')

cpu_cluster.wait_for_completion(show_output=True)
```

AZURE ML PYTHON SDK V2 (PREVIEW)

- v1舊版：pip install azureml-sdk[notebooks,automl,explain]
- v2新版：pip install --pre azure-ai-ml

The screenshot shows a Microsoft Edge browser window displaying the Azure Machine Learning documentation at <https://docs.microsoft.com/en-us/azure/machine-learning/>. The page title is "Azure Machine Learning documentation". The left sidebar contains a navigation menu for "Azure Machine Learning Documentation", including sections like "Overview", "Quickstart", "Tutorials" (with sub-sections for Python get started, Jupyter Notebooks, Studio, Visual Studio Code, and Microsoft Power BI integration), and "Resources". The main content area features three cards: "Overview" (with links to "OVERVIEW", "What is Azure Machine Learning?", "What is Azure Machine Learning studio?", "Key concepts (v2)", and "What is CLI & SDK v2?"), "Get Started" (with links to "TUTORIAL", "Set up resources", "Train with the v2 CLI", "Train with the v2 SDK (preview)", "Day 1: Get started with Python", and "Migrate from ML Studio (classic)"), and "Train models" (with links to "HOW-TO GUIDE", "Run training code in the cloud (v2 CLI)", "Train and deploy a model in Jupyter notebook", "Tune hyperparameters for model training", "Build pipelines from reusable components", and "AutoML: Train a classification model"). The top navigation bar includes links for Microsoft, Docs, Documentation, Learn, Certifications, Q&A, Code Samples, Shows, Events, a search bar, and account options.

MATERIALS (1)

Train models with the Azure ML Python SDK v2 (preview)

Microsoft | Docs [Documentation](#) Learn Certifications Q&A Code Samples Shows Events

Search  Portal [Free account](#)

Azure Product documentation ▾ Architecture ▾ Learn Azure ▾ Develop ▾ Resources ▾

 Filter by title

Docs / Azure / Machine Learning /

Train models with the Azure ML Python SDK v2 (preview)

Article • 07/27/2022 • 6 minutes to read • 7 contributors  

APPLIES TO:  [Python SDK azure-ai-ml v2 \(preview\)](#)

Select the Azure Machine Learning SDK version you are using: [v2 \(preview\) ▾](#)

 **Important**

SDK v2 is currently in public preview. The preview version is provided without a service level agreement, and it's not recommended for production workloads. Certain features might not be supported or might have constrained capabilities. For more information, see [Supplemental Terms of Use for Microsoft Azure Previews](#).

In this article, you learn how to configure and submit Azure Machine Learning jobs to train your models. Snippets of code explain the key parts of configuration and submission of a training job. Then use one of the example notebooks to find the full end-to-end working examples.



MATERIALS (2)

Tutorial: Create production ML pipelines with Python SDK v2 (preview) in a Jupyter notebook

1332 lines (1332 sloc) | 44.9 KB

<>  Raw Blame   

Tutorial: Create production ML pipelines with Python SDK v2 (preview) in a Jupyter notebook

Learning Objectives - By the end of this two part tutorial, you should be able to use Azure Machine Learning (Azure ML) to productionize your ML project.

This means you will be able to leverage the AzureML Python SDK to:

- connect to your Azure ML workspace
- create Azure ML data assets
- create reusable Azure ML components
- create, validate and run Azure ML pipelines
- deploy the newly-trained model as an endpoint
- call the Azure ML endpoint for inferencing

MATERIALS (3)

Configuration

218 lines (218 sloc) | 8.12 KB

<>  Raw Blame  

Configuration

Setting up your Azure Machine Learning services workspace and configuring needed resources

Requirements - In order to benefit from this tutorial, you will need:

- A basic understanding of Machine Learning
- An Azure account with an active subscription. [Create an account for free](#)
- An Azure ML workspace - [Create workspace](#)
- A python environment
- Installed Azure Machine Learning Python SDK v2 - [install instructions](#) - check the getting started section

Learning Objectives - By the end of this tutorial, you should be able to:

- Connect to your AML workspace from the Python SDK using different auth credentials
- Create workspace config file
- Create Compute clusters which required by jobs notebooks. [Check this notebook to create a compute cluster](#)

Motivations - This notebook covers the scenario that user define components using yaml then use these components to build pipeline.

ON-PREMISES DEVELOPMENT

STEPS

- 複製 Repository。
- 建立 Conda Virtual Environment 與初始化 Poetry 專案。
- (Optional) 安裝 lightGBM 前置作業。
- 透過 Conda + Poetry 控管相關 Python 與 Python Package 的版本。
- 進行 Model Training。

```
% git clone https://github.com/MonsterSupreme/AgileSummit2022.git  
% cd AgileSummit2022  
% conda create --name amlsdkv2 python=3.9 pip  
% poetry init  
(Optional) % brew install cmake libomp  
% poetry add mlflow argparse pandas lightgbm matplotlib sklearn  
% python src/main.py \  
  --iris-csv https://azuralexamples.blob.core.windows.net/datasets/iris.csv \  
  --learning-rate 0.9 \  
  --boosting gbdt
```

CLONE REPOSITORY

```
~/programming % git clone https://github.com/MonsterSupreme/AgileSummit2022.git
Cloning into 'AgileSummit2022'...
remote: Enumerating objects: 10, done.
remote: Counting objects: 100% (10/10), done.
remote: Compressing objects: 100% (6/6), done.
remote: Total 10 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (10/10), done.
~/programming %
```

```
~/programming % git clone https://github.com/MonsterSupreme/AgileSummit2022.git
Cloning into 'AgileSummit2022'...
remote: Enumerating objects: 10, done.
remote: Counting objects: 100% (10/10), done.
remote: Compressing objects: 100% (6/6), done.
remote: Total 10 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (10/10), done.
~/programming %
```

CREATE CONDA VIRTUAL ENVIRONMENT

```
~/programming/AgileSummit2022 % conda create --name amlsdkv2 python=3.9 pip
Collecting package metadata (current_repodata.json): done
Solving environment: done

## Package Plan ##

environment location: /Users/monster/miniforge/envs/mlsdkv2

added / updated specs:
- pip
- python=3.9

Retrieving notices: ...working... done
~/programming/AgileSummit2022 %
```

```
~/programming/AgileSummit2022 % conda create --name amlsdkv2 python=3.9 pip
Collecting package metadata (current_repodata.json): done
Solving environment: done

## Package Plan ##

environment location: /Users/monster/miniforge/envs/mlsdkv2

added / updated specs:
- pip
- python=3.9
```

INITIALIZE POETRY PROJECT

```
% conda activate amlsdkv2  
(amlsdkv2) ~/programming/AgileSummit2022 % poetry init
```

This command will guide you through creating your `pyproject.toml` config.

```
Package name [agilesummit2022]:  
Version [0.1.0]:  
Description []:  
Author [Monster Supreme <monster.supreme@gmail.com>, n to skip]:  
License []:  
Compatible Python versions [^3.9]: >=3.9,<3.10
```

```
(amlsdkv2) ~/programming/AgileSummit2022 %
```

```
~/programming/AgileSummit2022 % conda activate amlsdkv2  
(amlsdkv2) ~/programming/AgileSummit2022 % poetry init
```

This command will guide you through creating your `pyproject.toml` config.

```
Package name [agilesummit2022]:  
Version [0.1.0]:  
Description []:  
Author [Monster Supreme <monster.supreme@gmail.com>, n to skip]:  
License []:  
Compatible Python versions [^3.9]: >=3.9,<3.10
```

INSTALL REQUIRED TOOLS

- 如果是 Apple M1/M2 Silicon CPU，記得先安裝 cmake 與 libomp。

```
% brew install cmake libomp
```

```
File "/Users/monster/miniforge/envs/mlkv2/lib/python3.9/site-packages/setuptools/dist.py", line 1217, in run_command
    super().run_command(command)
File "/Users/monster/miniforge/envs/mlkv2/lib/python3.9/site-packages/setuptools/_distutils/dist.py", line 992, in run_command
    cmd_obj.run()
File "/private/var/folders/d9/d0n0_w_11l7gv304xjf4bm90000gn/T/pip-req-build-no6ltzys/setup.py", line 248, in run
    compile_cpp(use_mingw=self.mingw, use_gpu=self.gpu, use_cuda=self.cuda, use_mpi=self.mpi,
File "/private/var/folders/d9/d0n0_w_11l7gv304xjf4bm90000gn/T/pip-req-build-no6ltzys/setup.py", line 198, in compile_cpp
    silent_call(cmake_cmd, raise_error=True, error_msg='Please install CMake and all required dependencies first')
File "/private/var/folders/d9/d0n0_w_11l7gv304xjf4bm90000gn/T/pip-req-build-no6ltzys/setup.py", line 99, in silent_call
    raise Exception("\n".join((error_msg, LOG_NOTICE)))
Exception: Please install CMake and all required dependencies first
The full version of error log was saved into /Users/monster/LightGBM_compilation.log
[end of output]
```

note: This error originates from a subprocess, and is likely not a problem with pip.
error: legacy-install-failure

X Encountered error while trying to install package.
↳ lightgbm

note: This is an issue with the package mentioned above, not pip.
hint: See above for output from the failure.

INSTALL PYTHON PACKAGES

```
(amlsdkv2) ~/programming/AgileSummit2022 % poetry add mlflow argparse pandas lightgbm matplotlib sklearn
Using version ^1.28.0 for mlflow
Using version ^1.4.0 for argparse
Using version ^1.4.3 for pandas
Using version ^3.3.2 for lightgbm
Using version ^3.5.3 for matplotlib
Using version ^0.0 for sklearn

Package operations: 1 install, 0 updates, 0 removals

• Installing lightgbm (3.3.2)
(amlsdkv2) ~/programming/AgileSummit2022 %
```

```
(amlsdkv2) ~/programming/AgileSummit2022 % poetry add mlflow argparse pandas lightgbm matplotlib sklearn
Using version ^1.28.0 for mlflow
Using version ^1.4.0 for argparse
Using version ^1.4.3 for pandas
Using version ^3.3.2 for lightgbm
Using version ^3.5.3 for matplotlib
Using version ^0.0 for sklearn

Updating dependencies
Resolving dependencies... (0.3s)

Package operations: 1 install, 0 updates, 0 removals

• Installing lightgbm (3.3.2)
(amlsdkv2) ~/programming/AgileSummit2022 %
```

TRAIN MODEL

```
% python src/main.py --iris-csv https://azuremlexamples.blob.core.windows.net/datasets/iris.csv \
--learning-rate 0.9 --boosting gbdt
2022/08/28 20:11:52 INFO mlflow.tracking.fluent: Autologging successfully enabled for sklearn.
2022/08/28 20:11:52 INFO mlflow.tracking.fluent: Autologging successfully enabled for lightgbm.
2022/08/28 20:11:54 INFO mlflow.utils.autologging_utils: Created MLflow autologging run with ID '554fb6f72c9f461c9740f365'
/Users/monster/miniforge/envs/mlsdkv2/lib/python3.9/site-packages/lightgbm/engine.py:177: UserWarning: Found `num_iterat
[LightGBM] [Warning] Auto-choosing col-wise multi-threading, the overhead of testing was 0.026633 seconds. You can set `:
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
...
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
2022/08/28 20:11:56 WARNING mlflow.utils.autologging_utils: MLflow autologging encountered a warning: "/Users/monster/min
```

```
(amlsdkv2) ~/programming/AgileSummit2022 % python src/main.py --iris-csv https://azuremlexamples.blob.core.windows.net/datasets/iris.csv --learning-rate 0.9 --boosting gbdt
2022/08/28 20:11:52 INFO mlflow.tracking.fluent: Autologging successfully enabled for sklearn.
2022/08/28 20:11:52 INFO mlflow.tracking.fluent: Autologging successfully enabled for lightgbm.
2022/08/28 20:11:54 INFO mlflow.utils.autologging_utils: Created MLflow autologging run with ID '554fb6f72c9f461c9740f3654d9a7d8d', which will track hyperparameters, perfor
mance metrics, model artifacts, and lineage information for the current lightgbm workflow
/Users/monster/miniforge/envs/mlsdkv2/lib/python3.9/site-packages/lightgbm/engine.py:177: UserWarning: Found `num_iterations` in params. Will use it instead of argument
    _log_warning(f"Found '{alias}' in params. Will use it instead of argument")
[LightGBM] [Warning] Auto-choosing col-wise multi-threading, the overhead of testing was 0.026633 seconds.
You can set `force_col_wise=true` to remove the overhead.
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
2022/08/28 20:11:56 WARNING mlflow.utils.autologging_utils: MLflow autologging encountered a warning: "/Users/monster/miniforge/envs/mlsdkv2/lib/python3.9/site-packages/_d
istutils_hack/__init__.py:33: UserWarning: Setuptools is replacing distutils."
(amlsdkv2) ~/programming/AgileSummit2022 %
```

AZURE MACHINE LEARNING PYTHON SDK V2

STEPS

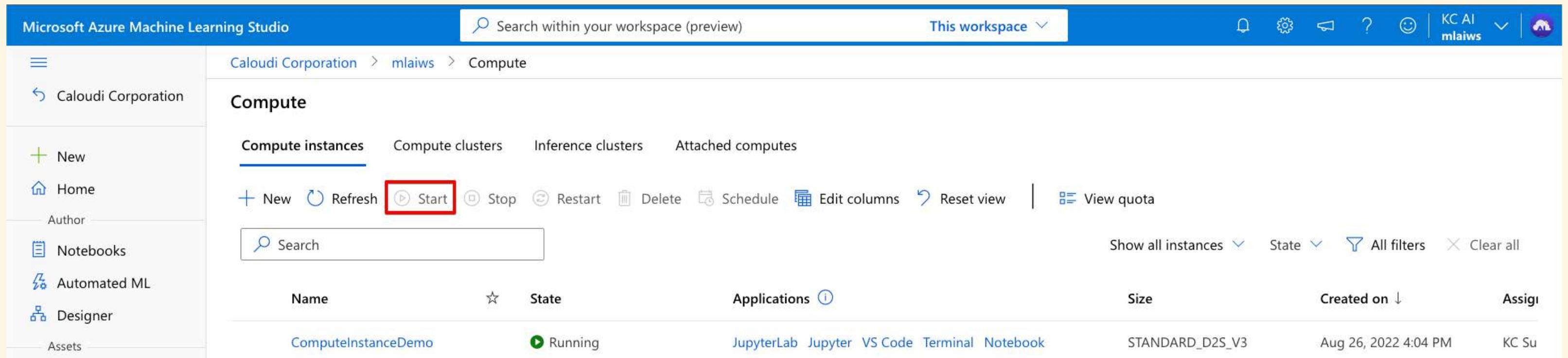
- 啟動 Azure Machine Learning Workspace。
- 啟動 Compute Instance。
- 打開 Compute Instance 的 Terminal。
- 複製 GitHub Repository。
- 啟動 Compute Instance 的 Jupyter。
- 打開 Jupyter Notebook 檔案。
- 安裝並且匯入 Azure Machine Learning Python SDK v2。
- 設定 Credential。
- 連上 Azure Machine Learning Workspace。
- 透過 `AmlCompute Class` 建立新的或透過 `MLClient Class` 找出既有的 Compute Target。
- 建立代表 Job 的 `command Function` 與 `Input Class`。
- 送出 Job 執行。

PREREQUISITES

- 要有 Azure Subscription (找出 Subscription ID)。
- 建好 Resource Group (存放 Azure Machine Learning Workspace / 記住名稱)。
- 建好 Azure Machine Learning Workspace (記住名稱)。
- 建好 Compute Instance 與 Compute Cluster (記住名稱)。

START COMPUTE INSTANCE

- 如果 Compute Instance 沒有啟動，就按下 Start。



The screenshot shows the Microsoft Azure Machine Learning Studio interface. The top navigation bar includes the studio name, a search bar, workspace selection, and user profile. The left sidebar has a tree view of the workspace structure: Caloudi Corporation > mlaiws > Compute. The main content area is titled 'Compute' and contains four tabs: 'Compute instances' (selected), 'Compute clusters', 'Inference clusters', and 'Attached computes'. Below the tabs is a toolbar with actions: New, Refresh, Start (which is highlighted with a red box), Stop, Restart, Delete, Schedule, Edit columns, Reset view, and View quota. A search bar is located below the toolbar. The main table lists one compute instance: 'ComputeInstanceDemo' (Name), 'Running' (State), 'JupyterLab Jupyter VS Code Terminal Notebook' (Applications), 'STANDARD_D2S_V3' (Size), 'Aug 26, 2022 4:04 PM' (Created on), and 'KC Su' (Assigned to). Filter options like 'Show all instances', 'State', 'All filters', and 'Clear all' are at the bottom of the table.

Name	State	Applications	Size	Created on	Assigned to
ComputeInstanceDemo	Running	JupyterLab Jupyter VS Code Terminal Notebook	STANDARD_D2S_V3	Aug 26, 2022 4:04 PM	KC Su

OPEN TERMINAL

- 打開 Terminal •

Microsoft Azure Machine Learning Studio

Search within your workspace (preview)

This workspace

Caloudi Corporation > mlaiws > Compute

Compute

Compute instances Compute clusters Inference clusters Attached computes

+ New Refresh Start Stop Restart Delete Schedule Edit columns Reset view View quota

Search Show all instances State All filters Clear all

Name	State	Applications	Size	Created on	Assigned to
ComputeInstanceDemo	Running	JupyterLab Jupyter VS Code Terminal Notebook	STANDARD_D2S_V3	Aug 26, 2022 4:04 PM	KC Su

Caloudi Corporation

New

Home

Author

Notebooks

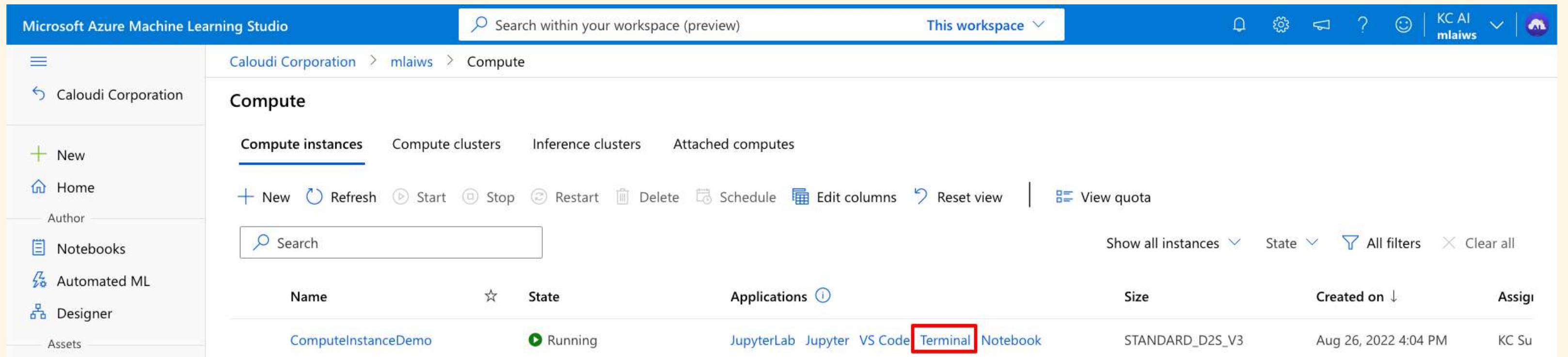
Automated ML

Designer

Assets

KC AI
mlaiws

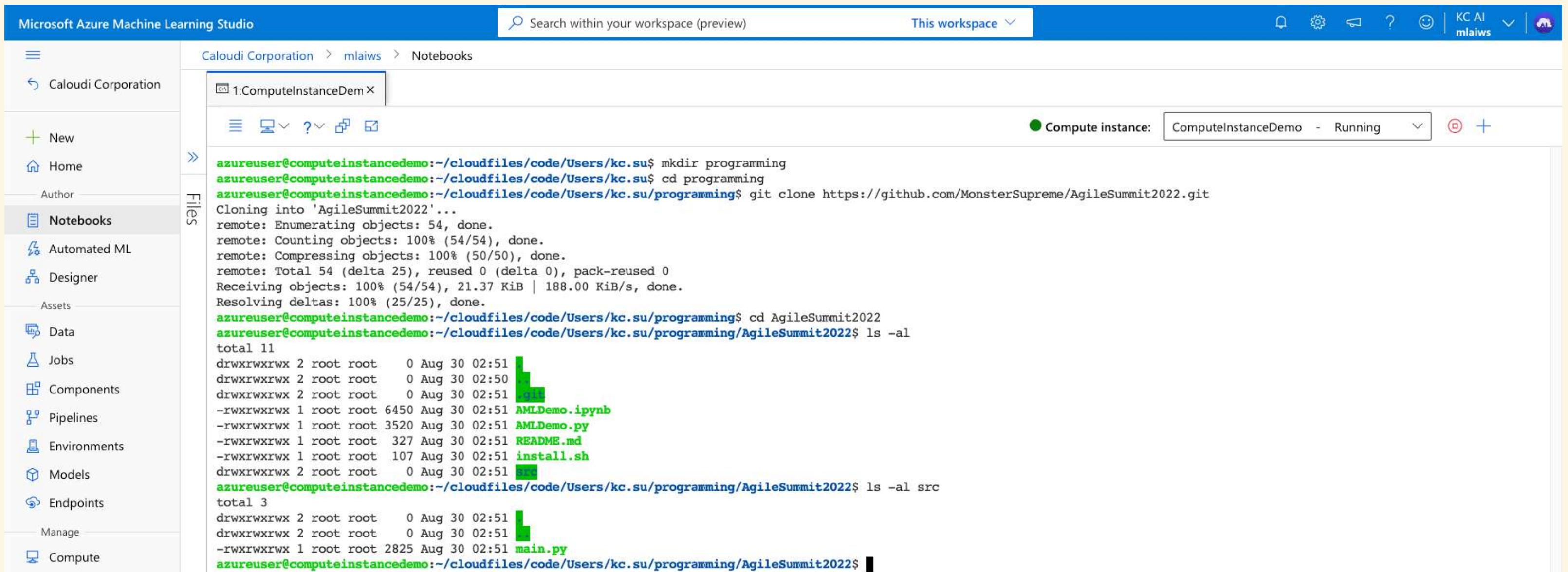
Caloudi



CLONE REPOSITORY

- 複製 AgileSummit2022 Repository °

```
~/programming $ git clone https://github.com/MonsterSupreme/AgileSummit2022.git
```



The screenshot shows a Microsoft Azure Machine Learning Studio interface. On the left, there's a sidebar with various workspace navigation options like Caloudi Corporation, New, Home, Author, Notebooks, Automated ML, Designer, Assets, Data, Jobs, Components, Pipelines, Environments, Models, Endpoints, Manage, and Compute. The main area is titled "Caloudi Corporation > mlaiws > Notebooks" and contains a terminal window titled "1:ComputeInstanceDem X". The terminal output shows the command "git clone https://github.com/MonsterSupreme/AgileSummit2022.git" being run, followed by the progress of the cloning process. Once completed, the user runs "ls -al" to list the contents of the directory, which includes files like ".git", "AMLDemo.ipynb", "AMLDemo.py", "README.md", "install.sh", and "main.py". The status bar at the bottom of the terminal window indicates "azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming/AgileSummit2022\$". The top right corner of the interface shows the user "KC AI mlaiws" and various workspace management icons.

```

azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su$ mkdir programming
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su$ cd programming
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming$ git clone https://github.com/MonsterSupreme/AgileSummit2022.git
Cloning into 'AgileSummit2022'...
remote: Enumerating objects: 54, done.
remote: Counting objects: 100% (54/54), done.
remote: Compressing objects: 100% (50/50), done.
remote: Total 54 (delta 25), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (54/54), 21.37 KiB | 188.00 KiB/s, done.
Resolving deltas: 100% (25/25), done.
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming$ cd AgileSummit2022
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming/AgileSummit2022$ ls -al
total 11
drwxrwxrwx 2 root root 0 Aug 30 02:51 .
drwxrwxrwx 2 root root 0 Aug 30 02:50 .
drwxrwxrwx 2 root root 0 Aug 30 02:51 .git
-rwxrwxrwx 1 root root 6450 Aug 30 02:51 AMLDemo.ipynb
-rwxrwxrwx 1 root root 3520 Aug 30 02:51 AMLDemo.py
-rwxrwxrwx 1 root root 327 Aug 30 02:51 README.md
-rwxrwxrwx 1 root root 107 Aug 30 02:51 install.sh
drwxrwxrwx 2 root root 0 Aug 30 02:51 src
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming/AgileSummit2022$ ls -al src
total 3
drwxrwxrwx 2 root root 0 Aug 30 02:51 .
drwxrwxrwx 2 root root 0 Aug 30 02:51 .
-rwxrwxrwx 1 root root 2825 Aug 30 02:51 main.py
azurereuser@computeinstancedemo:/cloudfiles/code/Users/kc.su/programming/AgileSummit2022$ 
```

START JUPYTER SERVER

- 啟動 Jupyter Server •

Microsoft Azure Machine Learning Studio

Search within your workspace (preview)

This workspace

Caloudi Corporation > mlaiws > Compute

Compute

Compute instances Compute clusters Inference clusters Attached computes

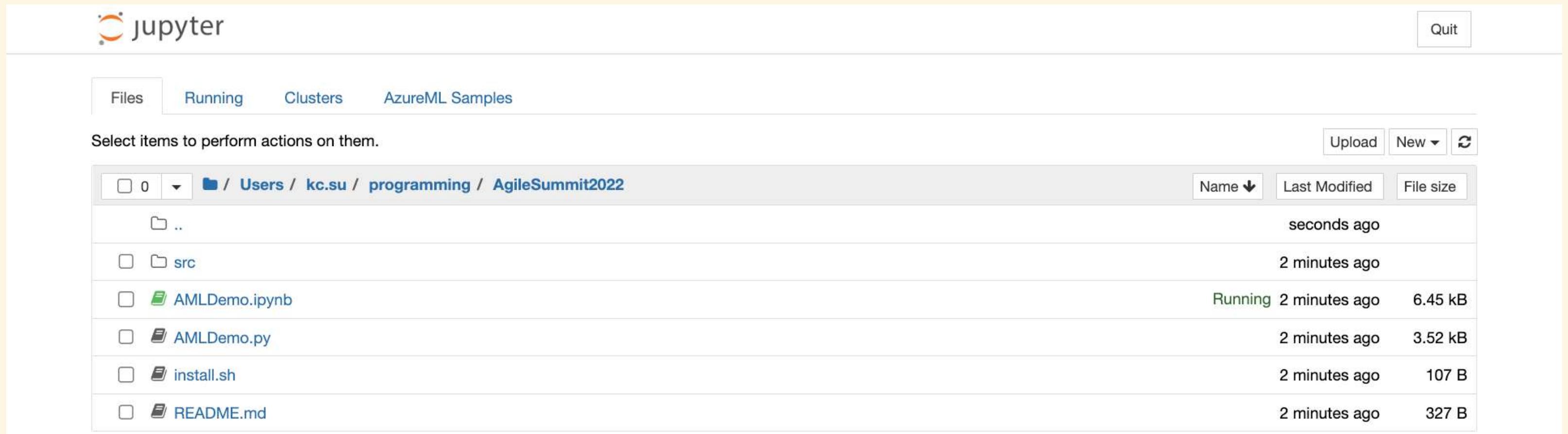
+ New Refresh Start Stop Restart Delete Schedule Edit columns Reset view View quota

Search

Name	State	Applications	Size	Created on	Assigned to
ComputeInstanceDemo	Running	JupyterLab Jupyter VS Code Terminal Notebook	STANDARD_D2S_V3	Aug 26, 2022 4:04 PM	KC Su

OPEN JUPYTER NOTEBOOK

- 開啟 `AMLDemo.ipynb` 檔案。



VERIFY THE EXISTENCE OF PYTHON SDK V2

- 確認有沒有安裝過舊的 `azure-ai-ml` Python SDK v2，有的話先移除。

```
pip uninstall azure-ai-ml --yes
```

```
In [2]: pip uninstall azure-ai-ml
```

WARNING: Skipping azure-ai-ml as it is not installed.

Note: you may need to restart the kernel to use updated packages.

```
In [2]: pip uninstall azure-ai-ml --yes
```

Found existing installation: azure-ai-ml 0.1.0b6

Uninstalling azure-ai-ml-0.1.0b6:

Successfully uninstalled azure-ai-ml-0.1.0b6

Note: you may need to restart the kernel to use updated packages.

INSTALL PYTHON SDK V2

- 目前只能安裝 Pre-Release 的 `azure-ai-ml` Python SDK v2。

```
pip install --pre azure-ai-ml
```

```
In [3]: pip install --pre azure-ai-ml

Collecting azure-ai-ml
  Downloading azure_ai_ml-0.1.0b6-py3-none-any.whl (2.7 MB)
    |████████| 2.7 MB 5.3 MB/s eta 0:00:01
Requirement already satisfied: azure-core!=1.22.0,<2.0.0,>=1.8.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from azure-ai-ml) (1.22.1)
Requirement already satisfied: azure-identity in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from azure-ai-ml) (1.7.0)
Collecting colorama<=0.4.4
  Downloading colorama-0.4.4-py2.py3-none-any.whl (16 kB)
Requirement already satisfied: azure-common<2.0.0,>=1.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from azure-ai-ml) (1.1.28)
Collecting tqdm<=4.63.0
  Downloading tqdm-4.63.0-py2.py3-none-any.whl (76 kB)
    |████████| 76 kB 2.9 MB/s eta 0:00:01
Requirement already satisfied: docker in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from azure-ai-ml) (5.0.3)
Collecting strictyaml<=1.6.1
  Downloading strictyaml-1.6.1.tar.gz (137 kB)
    |████████| 137 kB 40.6 MB/s eta 0:00:01
Collecting marshmallow<4.0.0,>=3.5
  Downloading marshmallow-3.17.1-py3-none-any.whl (48 kB)
```

INSTALL MLFLOW

- 安裝 Model Training 進度管控需要用到的 MLflow Library。

```
pip install mlflow azureml-mlflow
```

```
In [1]: pip install mlflow azureml-mlflow
```

```
Requirement already satisfied: mlflow in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (1.27.0)
Requirement already satisfied: azureml-mlflow in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (1.43.0.post1)
Requirement already satisfied: Flask in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.0.3)
Requirement already satisfied: entrypoints in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (0.4)
Requirement already satisfied: scipy in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.5.3)
Requirement already satisfied: gunicorn; platform_system != "Windows" in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlf
low) (20.1.0)
Requirement already satisfied: sqlalchemy>=1.4.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.4.39)
Requirement already satisfied: importlib-metadata!=4.7.0,>=3.7.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow)
(4.11.4)
Requirement already satisfied: pytz in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (2019.3)
Requirement already satisfied: packaging in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (21.3)
Requirement already satisfied: sqlparse>=0.3.1 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (0.4.2)
Requirement already satisfied: requests>=2.17.3 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (2.28.0)
Requirement already satisfied:云pickle in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.6.0)
Requirement already satisfied: alembic in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.8.1)
Requirement already satisfied: protobuf>=3.12.0 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (3.20.1)
Requirement already satisfied: databricks-cli>=0.8.7 in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (0.17.0)
Requirement already satisfied: numpy in /anaconda/envs/azureml_py38/lib/python3.8/site-packages (from mlflow) (1.19.0)
```

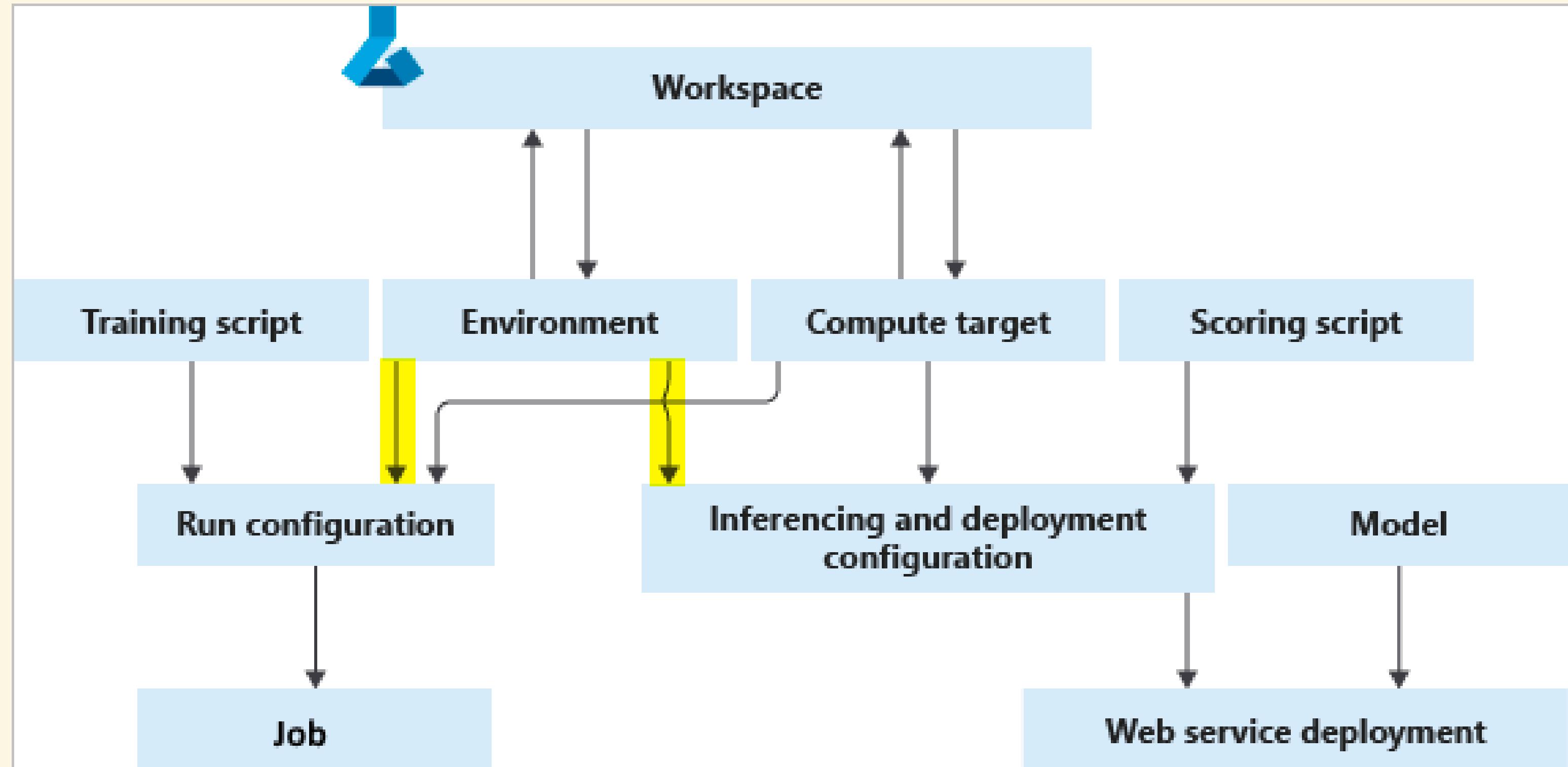
IMPORT LIBRARY

- 決入重要的 Python SDK 相關 Class。

```
# Import required classes and functions
from azure.identity import DefaultAzureCredential, InteractiveBrowserCredential
from azure.ai.ml import MLClient
from azure.ai.ml.entities import AmlCompute
from azure.ai.ml import command, Input
import mlflow
from azure.ai.ml.entities import Model
```

```
In [1]: # Import required classes and functions
# Credentials
from azure.identity import DefaultAzureCredential, InteractiveBrowserCredential
# Machine Learning Workspace
from azure.ai.ml import MLClient
# Compute Target
from azure.ai.ml.entities import AmlCompute
# Command and Arguments
from azure.ai.ml import command, Input
# MLflow Support
import mlflow
# Model
from azure.ai.ml.entities import Model
```

JOB VS. RUN CONFIGURATION VS. TRAINING SCRIPT / ENVIRONMENT / COMPUTE TARGET



DEFAULTAZURECREDENTIAL CLASS

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Version [Azure SDK for Python](#) Search

Docs / Reference / Identity / [azure-identity](#) / [azure.identity](#) /

DefaultAzureCredential Class

Reference  

A default credential capable of handling most Azure SDK authentication scenarios.

The identity it uses depends on the environment. When an access token is needed, it requests one using these identities in turn, stopping when one provides a token:

1. A service principal configured by environment variables. See [EnvironmentCredential](#) for more details.
2. An Azure managed identity. See [ManagedIdentityCredential](#) for more details.
3. On Windows only: a user who has signed in with a Microsoft application, such as Visual Studio. If multiple identities are in the cache, then the value of the environment variable `AZURE_USERNAME` is used to select which identity to use. See [SharedTokenCacheCredential](#) for more details.
4. The user currently signed in to Visual Studio Code.
5. The identity currently logged in to the Azure CLI.
6. The identity currently logged in to Azure PowerShell.

INTERACTIVEBROWSERCREDENTIAL CLASS

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Version [Docs](#) / Reference / Identity / [azure-identity](#) / [azure.identity](#) / [InteractiveBrowserCredential Class](#)

Azure SDK for Python 

Search 

azure.identity.
DefaultAzureCredential
azure.identity.
DeviceCodeCredential
azure.identity.
EnvironmentCredential
azure.identity.
InteractiveBrowserCredential 
azure.identity.KnownAuthorities

InteractiveBrowserCredential Class

Reference  

Opens a browser to interactively authenticate a user.

<xref:azure.identity.get_token> opens a browser to a login URL provided by Azure Active Directory and authenticates a user there with the authorization code flow, using PKCE (Proof Key for Code Exchange) internally to protect the code.

Inheritance `azure.identity._internal.interactive.InteractiveCredential` → `InteractiveBrowserCredential`

CONFIGURE CREDENTIAL

- DefaultAzureCredential 應該足以因應大多數的 Azure SDK Authentication 需求。
- 如果有問題，就 Fall Back 到 InteractiveBrowserCredential。

```
try:  
    credential = DefaultAzureCredential()  
    # Check if given credential can get token successfully.  
    credential.get_token("https://management.azure.com/.default")  
except Exception as ex:  
    # Fall back to InteractiveBrowserCredential in case DefaultAzureCredential not work  
    # This will open a browser page for  
    credential = InteractiveBrowserCredential()
```

In [2]:

```
try:  
    credential = DefaultAzureCredential()  
    # Check if given credential can get token successfully.  
    credential.get_token("https://management.azure.com/.default")  
except Exception as ex:  
    # Fall back to InteractiveBrowserCredential in case DefaultAzureCredential not work  
    # This will open a browser page for  
    credential = InteractiveBrowserCredential()
```

AZURE MACHINE LEARNING WORKSPACE

Microsoft Azure Machine Learning Studio

Search within your workspace (preview)

This workspace

Caloudi Corporation > mlaiws

mlaiws

Create new

Notebooks
Code with Python SDK and run sample experiments.
Start now

Automated ML
Automatically train and tune a model using a target metric.
Start now

Designer
Drag-and-drop interface from prepping data to deploying models.
Start now

Recent resources

Jobs Compute Models Data

Caloudi

MLCLIENT CLASS

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Version [Azure SDK for Python Preview](#) Search Overview [Overview](#) [azure.ai.ml](#) [Overview](#) [azure.ai.ml.automl](#) [azure.ai.ml.constants](#) [azure.ai.ml.dsl](#) [azure.ai.ml.entities](#) [azure.ai.ml.identity](#) [azure.ai.ml.operations](#) [azure.ai.ml.parallel](#) [azure.ai.ml.sweep](#) [azure.ai.ml.AmlToken](#) [azure.ai.ml.Input](#) [azure.ai.ml.MLClient](#)

... / Other / Uncategorized Packages / [azure-ai-ml](#) / [azure.ai.ml](#) / [MLClient Class](#)

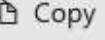
Reference  

A client class to interact with Azure ML services.

Use this client to manage Azure ML resources, e.g. workspaces, jobs, models and so on.

Inheritance `builtins.object` → `MLClient`

Constructor

Python 

```
MLClient(credential:  
         azure.identity._credentials.chained.ChainedTokenCredential, subscription_id:  
         str, resource_group_name: str, workspace_name: Optional[str] = None, **kwargs:  
         Any)
```

In this article

- [Constructor](#)
- [Methods](#)
- [Attributes](#)

LAZILY CONNECT TO AZURE MACHINE LEARNING WORKSPACE

- 調整相關參數，建構 `MLClient` 物件。

```
# Get a handle to the workspace
ml_client = MLClient(
    credential=credential,
    subscription_id="<<SUBSCRIPTION_ID>>",
    resource_group_name="<<RESOURCE_GROUP>>",
    workspace_name="<<AML_WORKSPACE_NAME>>"
)
print(ml_client)
```

```
In [3]: # Get a handle to the workspace
ml_client = MLClient(
    credential=credential,
    subscription_id="",
    resource_group_name="RG_MachineLearning",
    workspace_name="mlaiws"
)
print(ml_client)

MLClient(credential=<azure.identity._credentials.default.DefaultAzureCredential object at 0x7fd583b3b9a0>,
    subscription_id="",
    resource_group_name=RG_MachineLearning,
    workspace_name=mlaiws)
```

COMPUTE TARGET DEFINITION

- 確認您使用的 Compute Target 名稱。

The screenshot shows the Microsoft Azure Machine Learning Studio interface. The top navigation bar includes the title "Microsoft Azure Machine Learning Studio", a search bar "Search within your workspace (preview)", and a dropdown "This workspace". On the far right, there are notification icons (with 1 notification), settings, help, and user profile ("KC AI mlaiws").

The left sidebar has a tree view: "Caloudi Corporation > mlaiws > Compute". Below it are buttons for "New", "Home", "Author", "Notebooks", "Automated ML", "Designer", and "Assets".

The main content area is titled "Compute" and shows the "Compute clusters" tab selected. Other tabs include "Compute instances", "Inference clusters", and "Attached computes".

Below the tabs are actions: "+ New", "Refresh", "Delete", "Edit columns", "Reset view", and "View quota". There is also a "Search" bar.

Filtering options include "State", "Location", "All filters", and "Clear all".

A table lists the compute clusters:

Name	State	Size	Location	Created on	Active runs	Idle nodes	Busy nodes	Unprovisioned nodes
ComputeClusterDemo	Succeeded (0 nodes)	STANDARD_D2S_V3	westus3	Aug 29, 2022 11:22 PM	0	0	0	2

AML COMPUTE CLASS

Microsoft | Docs [Documentation](#) Learn Certifications Q&A Code Samples Shows Events [Search](#) 

Version

Azure SDK for Python Preview

Search

azure.ai.ml.entities

- Overview
- azure.ai.ml.entities.**
- AmlCompute**
- azure.ai.ml.entities.
- AmlComputeNodeInfo
- azure.ai.ml.entities.
- AmlComputeSshSettings
- azure.ai.ml.entities.Asset
- azure.ai.ml.entities.
- AssignedUserConfiguration
- azure.ai.ml.entities.
- AzureBlobDatastore
- azure.ai.ml.entities.
- AzureDataLakeGen1Datastore
- azure.ai.ml.entities.

... / azure-ai-ml / azure.ai.ml / azure.ai.ml.entities /

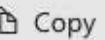
AmlCompute Class

Reference  

Aml Compute resource.

Inheritance `azure.ai.ml.entities._compute.compute.Compute` → `AmlCompute`

Constructor

Python 

```
AmlCompute(*, name: str, description: Optional[str] = None, size: Optional[str] = None, ssh_public_access_enabled: Optional[bool] = None, ssh_settings: Optional[azure.ai.ml.entities._compute.compute.AmlComputeSshSettings] = None, min_instances: Optional[int] = None, max_instances: Optional[int] = None, network_settings: Optional[azure.ai.ml.entities._compute.compute.NetworkSettings] = None, idle_time_before_scale_down: Optional[int] = None, identity: Optional[azure.ai.ml.entities._compute.identity.IdentityConfiguration] = None, tier: Optional[str] = None, **kwargs)
```

In this article

Constructor

GET COMPUTE TARGET

取得 Compute Target :

- 透過 AmlCompute Class 建立新的 Compute Target。
- 透過 MLClient Class 找出既有的 Compute Target。

```
compute_target_name = "ComputeClusterDemo"

try:
    # Check if the compute target already exists
    compute_target = ml_client.compute.get(compute_target_name)
    print(f"{compute_target.name} of node size {compute_target.size} is reused.")

except Exception:
    compute_target = AmlCompute(
        name=compute_target_name,
        type="amlcompute",
        size="Standard_D2s_v3",
        min_instances=0,
        max_instances=1,
        idle_time_before_scale_down=120,
        tier="Dedicated"
    )
    compute_target = ml_client.begin_create_or_update(compute_target)
    print(f"{compute_target.name} of node size {compute_target.size} is created.")
```

GET COMPUTE TARGET

```
In [5]: # Get the compute target
compute_target_name = "ComputeClusterDemo"

try:
    # Check if the compute target already exists
    compute_target = ml_client.compute.get(compute_target_name)
    print(f"{compute_target.name} of node size {compute_target.size} is reused.")
except Exception:
    compute_target = AmlCompute(
        name=compute_target_name,
        type="amlcompute",
        size="Standard_D2s_v3",
        min_instances=0,
        max_instances=2,
        idle_time_before_scale_down=120,
        tier="Dedicated"
    )
    compute_target = ml_client.begin_create_or_update(compute_target)
    print(f"{compute_target.name} of node size {compute_target.size} is created.")
```

ComputeClusterDemo of node size STANDARD_D2S_V3 is reused.

COMMAND FUNCTION

Version

Azure SDK for Python Preview

 Search

- ✓ azure-ai-ml
 - Overview
- ✓ azure.ai.ml
 - Overview
 - > azure.ai.ml.automl
 - > azure.ai.ml.constants
 - azure.ai.ml.dsl
 - > azure.ai.ml.entities
 - > azure.ai.ml.identity
 - > azure.ai.ml.operations
 - > azure.ai.ml.parallel
 - > azure.ai.ml.sweep
 - azure.ai.ml.AmlToken
 - azure.ai.ml.Input
 - azure.ai.ml.MLClient
 - azure.ai.ml.ManagedIdentity

Functions

command

Create a Command object which can be used inside dsl.pipeline as a function and can also be created as a standalone command job.

Python

 Copy

```
command(*, name: Optional[str] = None, description: Optional[str] = None,
tags: Optional[Dict] = None, properties: Optional[Dict] = None,
display_name: Optional[str] = None, command: Optional[str] = None,
experiment_name: Optional[str] = None, environment: Optional[Union[str,
azure.ai.ml.entities._assets.environment.Environment]] = None,
environment_variables: Optional[Dict] = None, distribution:
Optional[Union[Dict, azure.ai.ml.entities._job.distribution.MpiDistribution,
azure.ai.ml.entities._job.distribution.TensorFlowDistribution,
azure.ai.ml.entities._job.distribution.PyTorchDistribution]] = None,
compute: Optional[str] = None, inputs: Optional[Dict] = None, outputs:
Optional[Dict] = None, instance_count: Optional[int] = None, instance_type:
Optional[str] = None, timeout: Optional[int] = None, code:
Optional[Union[os.PathLike, str]] = None, identity:
Optional[Union[azure.ai.ml._restclient.v2022_02_01_preview.models._models_py3.I
azure.ai.ml._restclient.v2022_02_01_preview.models._models_py3.AmlToken,
azure.ai.ml._restclient.v2022_02_01_preview.models._models_py3.UserIdentity]] =
None, is_deterministic: bool = True, **kwargs) ->
azure.ai.ml.entities._builders.command.Command
```

INPUT CLASS

Microsoft | Docs [Documentation](#) Learn Certifications Q&A Code Samples Shows Events [Search](#) 

Version [Azure SDK for Python Preview](#) Search

Overview [Overview](#)

azure.ai.ml [Overview](#)

azure.ai.ml.automl [Default to be a uri_folder Input.](#)

azure.ai.ml.constants [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.dsl [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.entities [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.identity [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.operations [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.parallel [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.sweep [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azure.ai.ml.AmlToken [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

azur... [Inheritance](#) `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

Input Class

Reference  

Define an input of a Component or Job.

Default to be a `uri_folder` Input.

Inheritance `azure.ai.ml.entities._inputs_outputs._InputOutputBase → Input`

Constructor

Python 

```
Input(*, type: str = "'uri_folder'", path: str = 'None', mode: str = 'None',  
optional: bool = 'None', description: str = 'None', **kwargs)
```

CURATED ENVIRONMENT

- 可以使用 Azure Machine Learning 預先建好的 Environment。
- 可以使用自己定義的 Environment。

Microsoft Azure Machine Learning Studio Search within your workspace (preview) This workspace

Caloudi Corporation > mlaiws > Environments

Environments

Curated environments Custom environments

+ Create Refresh Edit columns Reset view

Python All filters Clear all

Showing 1-21 of 21 environments Page size: 25

Name ↑	Version	Created	Created ...	Tags
AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu	45	Aug 18, 2022 4:30 AM	Microsoft	dask : 2021.6 lightgbm : 3.2 OS : Ubuntu18.04 sklearn : 0.24 Training +1
AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu-inference	4	May 18, 2022 9:02 AM	Microsoft	Inference : True lightgbm : 3.2 OS : Ubuntu18.04 Python : 3.7
AzureML-minimal-ubuntu18.04-py37-cpu-inference	38	Aug 25, 2022 8:59 AM	Microsoft	Framework : None Inference OS : Ubuntu18.04 Python : 3.7
AzureML-minimal-ubuntu18.04-py37-cuda11.0.3-gpu-inference	5	Aug 25, 2022 8:59 AM	Microsoft	Framework : None GPU : Cuda11 Inference OS : Ubuntu18.04 Python : 3.7

PREPARE PYTHON JOB (1)

- 透過 command Function 定義 Job。

```
# Define the command
experiment_name = "AgileSummit2022"

command_job = command(
    experiment_name=experiment_name,
    code=".src",
    command="python main.py --iris-csv ${{inputs.csv}} --learning-rate ${{inputs.rate}} --boosting ${{inputs.boost}}",
    environment="AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu@latest",
    inputs={
        "csv": Input(
            type="uri_file",
            path="https://azuremlexamples.blob.core.windows.net/datasets/iris.csv",
        ),
        "rate": 0.9,
        "boost": "gbdt",
    },
    compute="ComputeClusterDemo",
)
```

PREPARE PYTHON JOB (2)

```
In [6]: # Define the command
experiment_name = "AgileSummit2022"

command_job = command(
    experiment_name=experiment_name,
    code=".src",
    command="python main.py --iris-csv ${{inputs.csv}} --learning-rate ${{inputs.rate}} --boosting ${{inputs.boost}}",
    environment="AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu@latest",
    inputs={
        "csv": Input(
            type="uri_file",
            path="https://azuremlexamples.blob.core.windows.net/datasets/iris.csv",
        ),
        "rate": 0.9,
        "boost": "gbdt",
    },
    compute="ComputeClusterDemo",
)
```

ENABLE LOGGING

- 啟用 MLflow 的 Auto Logging 功能。

```
# Enable logging  
mlflow.autolog()
```

In [7]: # Enable logging
mlflow.autolog()

```
2022/08/30 04:02:58 INFO mlflow.tracking.fluent: Autologging successfully enabled for pyspark.  
2022/08/30 04:02:58 INFO mlflow.pyspark.ml: No SparkSession detected. Autologging will log pyspark.ml models contained in the default allowlist. To specify a custom allowlist, initialize a SparkSession prior to calling mlflow.pyspark.ml.autolog() and specify the path to your allowlist file via the spark.mlflow.pysparkml.autolog.logModelAllowlistFile conf.  
2022/08/30 04:02:58 INFO mlflow.tracking.fluent: Autologging successfully enabled for pyspark.ml.
```

SUBMIT PYTHON JOB

- 送出 Job 執行。

```
# Submit the command
returned_job = ml_client.jobs.create_or_update(command_job)
print("Job name:", returned_job.name)
# Get a URL for the status of the job
print("Job url:", returned_job.services["Studio"].endpoint)
```

In [7]: # Submit the command
returned_job = ml_client.jobs.create_or_update(command_job)
print("Job name:", returned_job.name)

Get a URL for the status of the job
print("Job url:", returned_job.services["Studio"].endpoint)

```
Job name: frosty_mangos_q2n72hsfhb
Job url: https://ml.azure.com/runs/frosty_mangos_q2n72hsfhb?wsid=/subscriptions/630fbb67-7809-49f9-af9c-55704307b953/resourcegroups/RG_Mach
ineLearning/workspaces/mlaiws&tid=d18376e2-1716-4c44-bb34-672b431bebc2
```

FIND MODEL PATH

- 找出 Model 存放的位置。

```
# Find the model path
job_path = f"azureml://jobs/{returned_job.name}/outputs/artifacts/paths/model/"
print("Job path:", job_path)
```

In [8]: # Find the model path
job_path = f"azureml://jobs/{returned_job.name}/outputs/artifacts/paths/model/"
print("Job path:", job_path)

Job path: azureml://jobs/frosty_mangos_q2n72hsfhb/outputs/artifacts/paths/model/

TRACK STATUS (1)

- 追蹤 Model Training 進度。

```
# Tracking run status
import time

azureml_mlflow_uri = ml_client.workspaces.get(ml_client.workspace_name).mlflow_tracking_uri
mlflow.set_tracking_uri(azureml_mlflow_uri)
mlflow.set_experiment(experiment_name)

while True:
    run = mlflow.active_run()
    print("MLflow active_run:", run)
    if run != "None":
        break;
    else:
        time.sleep(5)

while True:
    status = mlflow.get_run(returned_job.name).info.status
    print("Job status:", status)
    if status == "FINISHED":
        break
    else:
        time.sleep(5)
```

TRACK STATUS (2)

```
In [9]: # Tracking run status
import time

azureml_mlflow_uri = ml_client.workspaces.get(ml_client.workspace_name).mlflow_tracking_uri
mlflow.set_tracking_uri(azureml_mlflow_uri)
mlflow.set_experiment(experiment_name)

while True:
    run = mlflow.active_run()
    print("MLflow active_run:", run)
    if run != "None":
        break;
    else:
        time.sleep(5)

while True:
    status = mlflow.get_run(returned_job.name).info.status
    print("Job status:", status)
    if status == "FINISHED":
        break
    else:
        time.sleep(5)
```

```
MLflow active_run: None
Job status: FINISHED
```

REGISTER MODEL

- 將 Model 註冊到 Azure Machine Learning 的 Model Registry。

```
# Register the model
run_model = Model(
    path=job_path,
    name="IrisModel",
    description=f"Model created from experiment {experiment_name} run {returned_job.name}.",
    type="mlflow_model"
)
ml_client.models.create_or_update(run_model)
print("Model registered")
```

```
In [10]: # Register the model
run_model = Model(
    path=job_path,
    name="IrisModel",
    description=f"Model created from experiment {experiment_name} run {returned_job.name}.",
    type="mlflow_model"
)
ml_client.models.create_or_update(run_model)
print("Model registered")
```

Model registered

CHECK STATUS (1)

Microsoft Azure Machine Learning Studio

Search within your workspace (preview) This workspace

Caloudi Corporation > mlaiws > Jobs > AgileSummit2022 > frosty_mangos_q2n72hsfhb

frosty_mangos_q2n72hsfhb Completed

Overview Metrics Images Child jobs Outputs + logs Code Explanations (preview) Fairness (preview) Monitoring (preview)

Refresh Access training applications Edit and submit Register model Cancel Delete

Properties

Status Completed	Created by KC Su
Created on Aug 30, 2022 12:07 PM	Job type Command
Start time Aug 30, 2022 12:08 PM	Experiment AgileSummit2022
Duration 16.08s	Environment AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu:45
Compute duration 16.08s	Registered models IrisModel:15
Name frosty_mangos_q2n72hsfhb	See all properties
Command python main.py --iris-csv \${{inputs.csv}} --learning-rate \${{inputs.rate}} --boosting \${{inputs.boost}}	Raw JSON
See YAML job definition	
Job YAML	

Compute

Target ComputeClusterDemo	GPUs 0
Compute type amlcompute	Instance count 1

Inputs

Input name: csv
Data: [azureml_jolly_pear_qlcwymdn6f_input_data_csv:1](#)

Outputs

Output name: mlflow_log_model_674446324
Model: [azureml_frosty_mangos_q2n72hsfhb_output_mlflow_log_model_674446324:1](#)

Tags

mlflow.autologging : lightgbm

Params

boosting : gbdt categorical_feature : auto early_stopping_rounds : None feature_name : auto
keep_training_booster : False learning_rate : 0.9 metric : multi_logloss num_boost_round : 10 num_class : 3
num_iterations : 16 num_leaves : 31 num_threads : 0 objective : multiclass seed : 42 verbose : 0
verbose_eval : True

Metrics

test-multi_logloss
Min: 0.03189035, Max: 0.1820419, Last: 0.03189035

CHECK STATUS (2)

Microsoft Azure Machine Learning Studio

Search within your workspace (preview) This workspace

Caloudi Corporation > mlaiws > Models > IrisModel:15

IrisModel:15 ☆

Details Versions Artifacts Endpoints Data Explanations (preview) Fairness (preview) Responsible AI

Refresh Deploy Download all

Attributes

- Name: IrisModel
- Version: 15
- Created on: Aug 30, 2022 12:09 PM
- Created by: KC Su
- Type: MLFLOW
- Job (Run ID): frosty_mangos_q2n72hsfhb

Tags

No tags

Properties

```
azureml.datastoreId : /subscriptions/630fbb67-7809-49f9-af9c-55704307b953/resourceGroups/RG_MachineLearning/providers/Microsoft.MachineLearningServices/workspaces/mlaiws/datastores/workspaceartifactstore
```

Description

Model created from experiment AgileSummit2022 run frosty_mangos_q2n72hsfhb.

Build your models responsibly. Try out the Responsible AI dashboard Try it out

Caloudi Corporation mlaiws

CHECK STATUS (3)

Microsoft Azure Machine Learning Studio Search within your workspace (preview) This workspace

Caloudi Corporation > mlaiws > Models > IrisModel:15

IrisModel:15

Details Versions Artifacts Endpoints Data Explanations (preview) Fairness (preview) Responsible AI

Refresh Download all

MLmodel

```

1 artifact_path: model
2 flavors:
3   lightgbm:
4     code: null
5     data: model.lgb
6     lgb_version: 3.2.1
7     model_class: lightgbm.basic.Booster
8   python_function:
9     data: model.lgb
10    env: conda.yaml
11    loader_module: mlflow.lightgbm
12    python_version: 3.7.13
13    mlflow_version: 1.28.0
14    model_uuid: cf0fe2696c4b451ab74f01910edb25a4
15    run_id: frosty_mangos_q2n72hsfhb
16    signature:
17      inputs: '[{"name": "sepal_length", "type": "double"}, {"name": "sepal_width", "type": "double"}, {"name": "petal_length", "type": "double"}, {"name": "petal_width", "type": "double"}]'
18      outputs: '[{"type": "tensor", "tensor-spec": {"dtype": "float64", "shape": [-1, 3]}}]'
19    utc_time_created: '2022-08-30 04:08:21.420835'
20
21
22
23

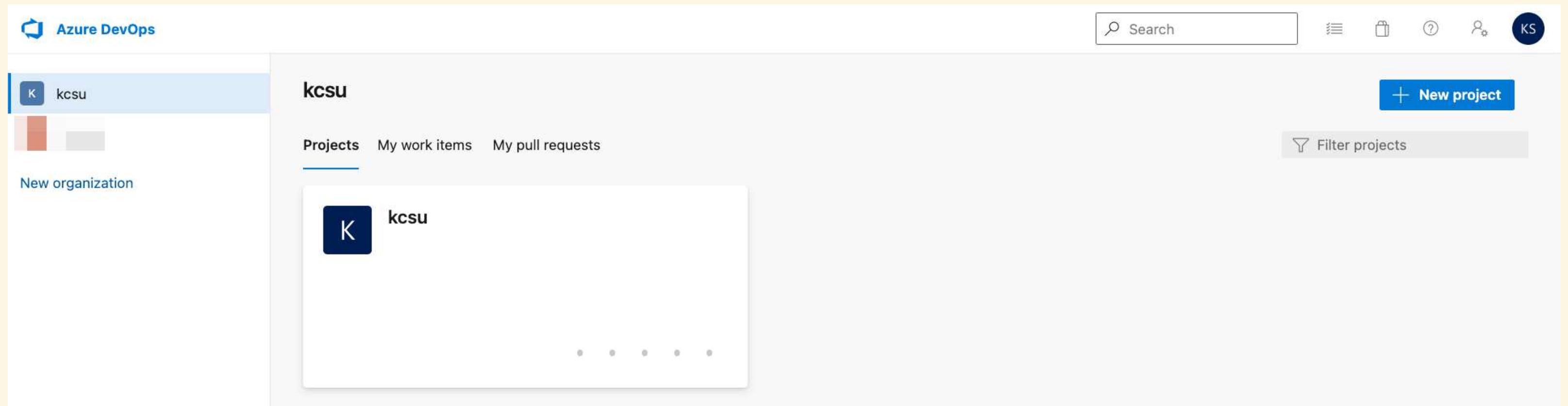
```

model
conda.yaml
MLmodel
model.lgb
python_env.yaml
requirements.txt

AZURE DEVOPS PIPELINE

FIND ORGANIZATION

- 登入 Azure DevOps，找到自己的 Organization。



CREATE PROJECT

- 建立 AgileSummit2022 專案。

The screenshot shows the Azure DevOps interface with a 'Create new project' dialog box overlaid. The dialog box has the following fields:

- Project name ***: AgileSummit2022
- Description**: (Empty)
- Visibility**:
 - Public**: Anyone on the internet can view the project. Certain features like TFVC are not supported.
 - Private**: Only people you give access to will be able to view this project. (This option is selected, indicated by a blue border and a checked radio button.)
- Advanced**: (Collapsed section)
- Create**: (Blue button)

The background shows the Azure DevOps dashboard for the 'kcsu' organization, featuring a large 'kcsu' placeholder card and navigation links for 'Projects', 'My work items', and 'My pull requests'.

IMPORT REPOSITORY

- 為了 Demo 方便，選擇從 GitHub Repository 進入範例檔案。

The screenshot shows the Azure DevOps interface for importing a GitHub repository. On the left, the navigation bar includes 'Overview', 'Boards', 'Repos' (selected), 'Files', 'Commits', 'Pushes', 'Branches', 'Tags', 'Pull requests', 'Pipelines', 'Test Plans', and 'Artifacts'. The main area displays the message 'AgileSummit2022 is empty. Add some code!' and provides cloning options via HTTPS and SSH. A red box highlights the 'Import a repository' button, which is then expanded into a modal dialog titled 'Import a Git repository'. The dialog shows 'Repository type' set to 'Git', 'Clone URL *' containing 'https://github.com/MonsterSupreme/AgileSummit2022.git', and a checked 'Requires Authentication' checkbox. At the bottom right of the dialog are 'Cancel' and 'Import' buttons.

CLONED REPOSITORY

Azure DevOps kcsu / AgileSummit2022 / Repos / Files / AgileSummit2022

Search

AgileSummit2022

Overview Boards

Repos

Files

src

AMLDemo.ipynb
PY AMLDemo.py
install.sh
README.md

main

Type to find a file or folder...

Files

Contents History

Name ↑	Last change	Commits
src	Yesterday	10ead8bc Upload main.py to repo. Monster Sup...
AMLDemo.ipynb	8m ago	e3c6e80d Update AMLDemo.ipynb Monster Sup...
PY AMLDemo.py	9m ago	4647c0f4 Update AMLDemo.py Monster Supreme
install.sh	1h ago	3b786162 Unused packages removed. Monster ...
README.md	1h ago	0ce1c35f Update README.md Monster Supreme

Agile Summit 2022

Sample code comes from [Azure Machine Learning Python SDK v2 \(preview\)](#).

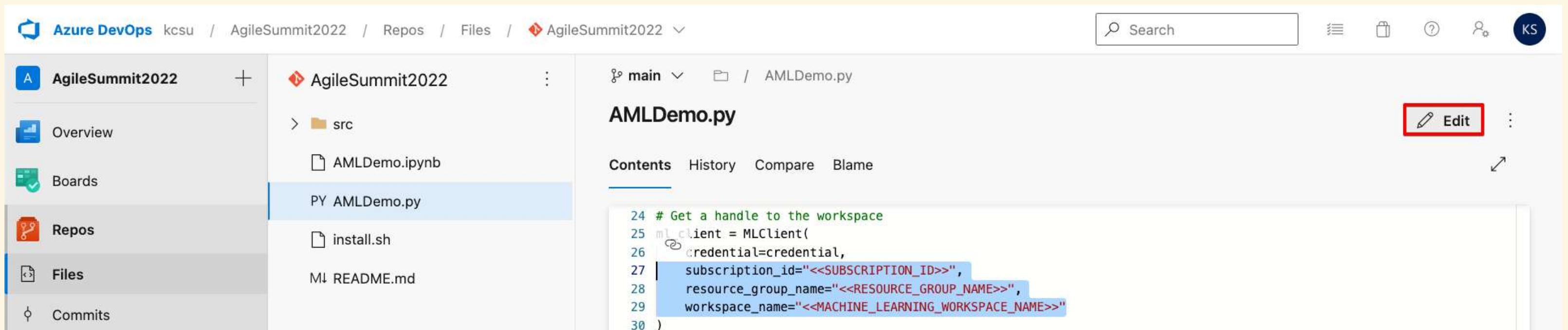
Training data comes from [Iris in Azure Example Datasets](#).

Set up build Clone

MODIFY SOURCE CODE

點擊 `AMLDemo.py` 檔案，按下 `Edit` 按鈕，改完之後按下 `Commit` 按鈕：

- `<<SUBSCRIPTION_ID>>` 改成您要使用的 Azure Subscription ID。
- `<<RESOURCE_GROUP_NAME>>` 改成您建置 Azure Machine Learning Workspace 的 Resource Group 名稱。
- `<< MACHINE_LEARNING_WORKSPACE_NAME>>` 改成您使用的 Azure Machine Learning Workspace 名稱。



CREATE PIPELINE (1)

- 準備建立 Azure DevOps Pipeline。

The screenshot shows the Azure DevOps Pipelines interface. In the top left, the path is displayed as Azure DevOps kcsu / AgileSummit2022 / Pipelines. The top right features a search bar, a ribbon menu, and user profile icons. On the far right, there's a circular icon with the letters 'KS'. The left sidebar contains navigation links: Overview, Boards, Repos, Pipelines (which is selected and highlighted in blue), Pipelines (under Pipelines), Environments, Releases, Library, Task groups, Deployment groups, Test Plans, and Artifacts. The main content area has a large, colorful illustration of a purple robot holding a blue shield, a person sitting at a desk with a laptop, and a small dog. Below the illustration, the text "Create your first Pipeline" is prominently displayed in bold black font. Underneath, a subtitle reads "Automate your build and release processes using our wizard, and go from code to cloud-hosted within minutes." A large blue button labeled "Create Pipeline" is centered at the bottom of this section.

CREATE PIPELINE (2)

- 使用 Classic Editor 比較習慣。

The screenshot shows the Azure DevOps interface for creating a new pipeline. The left sidebar is titled 'AgileSummit2022' and includes links for Overview, Boards, Repos, Pipelines (which is selected), Environments, Releases, Library, Task groups, Deployment groups, Test Plans, and Artifacts. The main area is titled 'Connect' and has tabs for 'Select' and 'Review'. A large heading 'Where is your code?' is displayed above a list of code sources. The list includes:

- Azure Repos Git (YAML) - Free private Git repositories, pull requests, and code search
- Bitbucket Cloud (YAML) - Hosted by Atlassian
- GitHub (YAML) - Home to the world's largest community of developers
- GitHub Enterprise Server (YAML) - The self-hosted version of GitHub Enterprise
- Other Git - Any generic Git repository
- Subversion - Centralized version control by Apache

At the bottom of the list, there is a red-bordered button with the text "Use the classic editor to create a pipeline without YAML."

CREATE PIPELINE (3)

- Pipeline 的 Source 來源就是剛剛建立的 Azure DevOps Repository。

The screenshot shows the Azure DevOps Pipelines interface. On the left, a sidebar menu is open for the project 'AgileSummit2022'. The 'Pipelines' item is selected. The main area displays a large circular arrow icon with the text 'Select your repository' and a sub-instruction: 'Tell us where your sources are. You can customize how to get these sources from the repository later.' To the right, a 'Select a source' section is shown, featuring a highlighted 'Azure Repos Git' option. Below it, configuration fields include 'Team project' set to 'AgileSummit2022', 'Repository' set to 'AgileSummit2022', and 'Default branch for manual and scheduled builds' set to 'main'. A 'Continue' button is at the bottom.

CREATE PIPELINE (4)

- 選擇 Empty Job 作為 Template 即可。

The screenshot shows the Azure DevOps interface for creating a new pipeline. The left sidebar shows the project 'AgileSummit2022' and the 'Pipelines' section is selected. A large circular arrow icon with the text 'Choose a template' is centered. To the right, a red box highlights the 'Select a template' section, which contains the text 'Or start with an [Empty job](#)'. Below this, there's a 'Configuration as code' section for YAML and a 'Featured' section for '.NET Desktop'. The top navigation bar includes 'Search' and user profile icons.

Azure DevOps kcsu / AgileSummit2022 / Pipelines

AgileSummit2022 +

Overview

Boards

Repos

Pipelines

Pipelines

Environments

Choose a template

Select a template
Or start with an [Empty job](#)

Configuration as code

[YAML](#)
Looking for a better experience to configure your pipelines using YAML files? Try the new YAML pipeline creation experience. [Learn more](#)

Featured

[!\[\]\(50f7a14b8beb19102886cd26fb1238a2_img.jpg\) .NET Desktop](#)
Build and test a .NET or Windows classic desktop solution.

CURATED ENVIRONMENT

- 我們用的 Environment 是 Ubuntu 18.04 / Python 3.7。

Microsoft Azure Machine Learning Studio Search within your workspace (preview) This workspace

Caloudi Corporation > mlaiws > Environments

Environments

Curated environments Custom environments

Create Refresh Edit columns Reset view

Python All filters Clear all

Showing 1-21 of 21 environments Page size: 25

Name ↑	Version	Created	Created ...	Tags
AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu	45	Aug 18, 2022 4:30 AM	Microsoft	dask : 2021.6 lightgbm : 3.2 OS : Ubuntu18.04 sklearn : 0.24 Training +1
AzureML-lightgbm-3.2-ubuntu18.04-py37-cpu-inference	4	May 18, 2022 9:02 AM	Microsoft	Inference : True lightgbm : 3.2 OS : Ubuntu18.04 Python : 3.7
AzureML-minimal-ubuntu18.04-py37-cpu-inference	38	Aug 25, 2022 8:59 AM	Microsoft	Framework : None Inference OS : Ubuntu18.04 Python : 3.7
AzureML-minimal-ubuntu18.04-py37-cuda11.0.3-gpu-inference	5	Aug 25, 2022 8:59 AM	Microsoft	Framework : None GPU : Cuda11 Inference OS : Ubuntu18.04 Python : 3.7

CREATE PIPELINE (5)

- Agent Specification 選取 ubuntu-18.04。

The screenshot shows the Azure DevOps Pipelines interface. On the left, there's a sidebar with various project navigation links like Overview, Boards, Repos, Pipelines, Environments, Releases, Library, Task groups, Deployment groups, Test Plans, and Artifacts. The 'Pipelines' link is currently selected. In the main area, a pipeline named 'AgileSummit2022-CI' is displayed under the 'AgileSummit2022' project. The pipeline has a single task named 'Get sources' which points to the 'AgileSummit2022' repository and the 'main' branch. Below this is an 'Agent job 1' section with the 'Run on agent' option selected. On the right, the pipeline configuration details are shown. The 'Name' field is set to 'AgileSummit2022-CI'. Under 'Agent pool', it says 'Azure Pipelines'. The 'Agent Specification' field is set to 'ubuntu-18.04' and is highlighted with a red border. Below this, there's a 'Parameters' section with a note: 'This pipeline doesn't have any pipeline parameters. Create them to share the most important settings between tasks and change them in one place.' A 'Learn more' link is also present.

CREATE PIPELINE (6)

新增 Use Python 3.x Task :

- Version spec 改為 3.7。

The screenshot shows the Azure DevOps Pipelines interface for the 'AgileSummit2022' project. The pipeline 'AgileSummit2022-CI' is selected. On the left sidebar, 'Pipelines' is highlighted. The main area shows the pipeline structure:

- Get sources**: Triggers: AgileSummit2022, main
- Agent job 1**: Run on agent
- Use Python 3.7**: Task type: Use Python version

The 'Use Python 3.7' task is currently configured with the following settings:

- Task version**: 0.*
- Display name ***: Use Python 3.7
- Version spec ***: 3.7
- Disable downloading releases from the GitHub registry
- Allow downloading unstable releases
- GitHub token for GitHub Actions python registry**: (empty field)
- Add to PATH

CREATE PIPELINE (7)

新增 Bash Task :

- Script Path 選取 install.sh。

The screenshot shows the Azure DevOps Pipelines interface for the AgileSummit2022 project. On the left, the sidebar is open with the 'Pipelines' section selected. In the center, the 'AgileSummit2022-CI' pipeline is displayed. The 'Tasks' tab is active, showing a list of tasks: 'Get sources', 'Agent job 1' (which contains 'Use Python 3.7'), and a newly added 'Bash Script (Install Library)' task. The 'Bash Script (Install Library)' task is currently being configured. The configuration pane on the right shows the following details:

- Task version: 3.*
- Display name: Bash Script (Install Library)
- Type: File Path (radio button selected)
- Script Path: install.sh
- Arguments: (empty)

CREATE PIPELINE (8)

新增 Azure CLI Task：

- Azure Resource Manager connection 選取 Machine Learning Workspace 所在的 Subscription，並且按下旁邊的 Authorize 按鈕進行驗證。
- Script Type 改為 Shell。
- Script Location 改為 Inline script。
- Inline Script 內容就是 python AMLDemo.py。

Pipelines

Environments

Releases

Library

Task groups

Deployment groups

Agent job 1

Run on agent

+

Display name *

Azure CLI

Azure Resource Manager connection *

Manage

KC AI

Authorise |

Click Authorise to configure an Azure service connection. A new Azure service principal will be created and added to the Contributor role, having access to all resources in the selected subscription. To restrict the scope of the service principal to a specific resource group, see [connect to Microsoft Azure](#).

Some settings need attention

Authorise |

CREATE PIPELINE (8)

Azure DevOps kcsu / AgileSummit2022 / Pipelines

Search

AgileSummit2022 ... > AgileSummit2022-CI

Overview Boards Repos Pipelines Environments Releases Library Task groups Deployment groups Test Plans Artifacts

Tasks Variables Triggers Options History Save & queue Discard Summary Queue ...

Pipeline Build pipeline

Get sources AgileSummit2022 main

Agent job 1 Run on agent

Use Python 3.7 Use Python version

Bash Script (Install Library) Bash

Azure CLI Azure CLI

Azure CLI

Link settings View YAML Remove

Task version 2.*

Display name * Azure CLI

Azure Resource Manager connection * KC AI Manage

KC AI

Scoped to subscription 'KC AI'

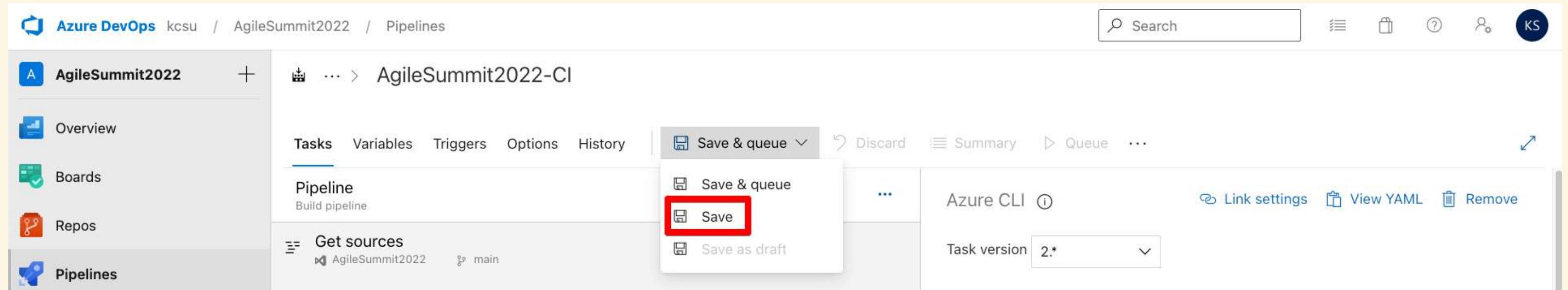
Script Type * Shell

Script Location * Inline script

Inline Script * python AMLDemo.py

CREATE PIPELINE(9)

- Save & queue 選取 Save。



CREATE PIPELINE (10)

- 然後送進 Queue 等候執行。

The screenshot shows the Azure DevOps Pipelines interface. On the left, there's a sidebar with icons for Overview, Boards, Repos, and Pipelines. The Pipelines icon is selected and highlighted with a grey background. In the main area, a pipeline named "AgileSummit2022-CI" is displayed. The pipeline has one task named "Get sources". At the top of the pipeline view, there are several buttons: "Tasks", "Variables", "Triggers", "Options", "History", "Save & queue", "Discard", "Summary", "Queue" (which is highlighted with a red box), and "...". Below the pipeline tasks, there are options for "Azure CLI", "Link settings", "View YAML", and "Remove". A dropdown menu for "Task version" is open, showing "2.*".

CREATE PIPELINE (11)

Azure DevOps kcsu / AgileSummit2022 / Pipelines

AgileSummit2022 + AgileSummit2022-CI

Overview Boards Repos Pipelines Pipelines Environments Releases Library Task groups Deployment groups Test Plans Artifacts Project settings

Tasks Variables Triggers Options History Save & queue Discard Summary

Pipeline Build pipeline

Get sources AgileSummit2022 main

Agent job 1 Run on agent

Use Python 3.7 Use Python version

Bash Script (Install Library) Bash

Azure CLI (Submit Job) Azure CLI

Run pipeline

Select parameters below and manually run the pipeline

Agent pool

Azure Pipelines

Agent Specification *

ubuntu-18.04

Task version 2.*

Display name *

Azure CLI (Subr...)

Azure Resource M...

KC AI (630fbb6...)

Scoped to subscriptio...

Script Type *

Shell

Variables 1 variable defined

Demands This pipeline has no defined demands

Script Location *

Inline script

Inline Script *

python src/main.py --iris-csv http://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.csv --learning-rate 0.01 --boosting iterations 100

Enable system diagnostics

Cancel Run

CREATE PIPELINE (12)

Azure DevOps kcsu / AgileSummit2022 / Pipelines / AgileSummit2022-CI / 1

Search

AgileSummit2022 +

#1 Added install.sh to / AgileSummit2022-CI

Cancel :

Overview

Boards

Repos

Pipelines

Pipelines

Environments

Releases

Library

Task groups

Deployment groups

Test Plans

Artifacts

Summary

Manually run by KC Su

View 8 changes

Repository and version

AgileSummit2022

main c4b9b3b0

Time started and elapsed

Just now

11s

Related

0 work items

1 consumed

Tests and coverage

Get started

Warnings 1

The ubuntu-18.04 environment is deprecated, consider switching to ubuntu-20.04(ubuntu-latest), or ubuntu-22.04 instead. For more details see <https://github.com/actions/runner/releases>

Jobs

Name	Status	Duration
Agent job 1	Queued	

CREATE PIPELINE (13)

Azure DevOps kcsu / AgileSummit2022 / Pipelines / AgileSummit2022-CI / 29

Search

AgileSummit2022 +

Overview

Boards

Repos

Pipelines

Pipelines

Environments

Releases

Library

Task groups

Deployment groups

← Jobs in run #29
AgileSummit2022-CI

Jobs

- Agent job 1 6m 32s
 - Initialize job 1s
 - Checkout AgileSummi... 1s
 - Use Python 3.7 <1s
 - Bash Script (Install L... 29s
 - Azure CLI 5m 59s
 - Post-job: Checkout A... <1s
 - Finalize Job <1s
 - Report build status <1s

Azure CLI

```

56 MLClient(credential=<azure.identity._credentials.default.DefaultAzureCredential object at 0x7f7af9784090>,
57 subscription_id=630fbb67-7809-49f9-af9c-55704307b953,
58 resource_group_name=RG_MachineLearning,
59 workspace_name=mlaiws)
60 ComputeClusterDemo of node size STANDARD_D2S_V3 is reused.
61 Job name: frank_wheel_qt01gsv6hx
62 Job url: https://ml.azure.com/runs/frank_wheel_qt01gsv6hx?wsid=/subscriptions/630fbb67-7809-49f9-af9c-55704307b953/resourceGroups/RG_MachineLearning/providers/Microsoft.ML/jobs/frank_wheel_qt01gsv6hx
63 Job path: azureml://jobs/frank_wheel_qt01gsv6hx/outputs/artifacts/paths/model/
64 MLflow active_run: None
65 Job status: SCHEDULED
66 Job status: SCHEDULED
67 Job status: SCHEDULED
68 Job status: SCHEDULED
69 Job status: SCHEDULED
70 Job status: SCHEDULED
71 Job status: SCHEDULED
72 Job status: SCHEDULED
73 Job status: SCHEDULED
74 Job status: SCHEDULED

```

View raw log

CREATE PIPELINE (14)

← [Build succeeded] AgileSummit2022-CI - AgileSummit2022:main - AgileSummit2022 - c4b9b3b0

Azure DevOps To: KC Su Microsoft Azure DevOps Mon 8/29/2022 12:36 AM

BUILD #1 SUCCEEDED

AgileSummit2022-CI

Ran for 71 seconds

[View results](#)

Summary

Build pipeline	AgileSummit2022-CI
Finished	Sun, Aug 28 2022 16:35:58 GMT+00:00
Requested for	KC Su
Reason	Manual

CONTINUOUS INTEGRATION (1)

- 找到 AgileSummit2022-CI Pipeline。

The screenshot shows the Azure DevOps Pipelines interface. On the left, there is a sidebar with the following items:

- Azure DevOps kcsu / AgileSummit2022 / Pipelines
- AgileSummit2022 +
- Overview
- Boards
- Repos
- Pipelines
- Pipelines (selected)
- Environments

The main area is titled "Pipelines" and has tabs for "Recent", "All", and "Runs". It displays "Recently run pipelines" with the following details:

Pipeline	Last run	
#1 • AgileSummit2022-CI	Manually triggered for main	5m ago 1m 10s

CONTINUOUS INTEGRATION (2)

- 按下 Edit 調整設定內容。

The screenshot shows the Azure DevOps Pipelines interface for the 'AgileSummit2022' project. The left sidebar has 'Pipelines' selected. The main area displays the 'AgileSummit2022-CI' pipeline. The pipeline details include:

- Description:** #1 Added install.sh to /
- Stages:** One stage is shown with a green checkmark.
- Trigger:** Manually triggered for main branch commit c4b9b3b0.
- Timestamps:** Triggered 6m ago, completed 1m 10s ago.

On the right, there are buttons for 'Edit' (highlighted with a red box) and 'Run pipeline'.

CONTINUOUS INTEGRATION (3)

- 按下 Triggers。

The screenshot shows the Azure DevOps Pipelines interface for the project "AgileSummit2022". The left sidebar is visible with the "Pipelines" item selected. The main area displays a pipeline named "AgileSummit2022-CI" with the following configuration:

- Triggers:** The "Triggers" tab is selected.
- Pipeline:** Build pipeline
- Get sources:** AgileSummit2022, main branch
- Agent job 1:** Run on agent
 - Use Python 3.7:** Use Python version
 - Bash Script (Install Library):** Bash
 - Azure CLI (Submit Job):** Azure CLI
- Parameters:** This pipeline doesn't have any pipeline parameters. Create them to share the most important settings between tasks and change them in one place.

CONTINUOUS INTEGRATION (4)

- 勾選 Enable continuous integration °

The screenshot shows the Azure DevOps Pipelines interface for the project 'AgileSummit2022'. The left sidebar is visible with options like Overview, Boards, Repos, Pipelines (which is selected), Pipelines, Environments, and Releases. The main area shows the pipeline 'AgileSummit2022-CI' with the 'Triggers' tab selected. Under the 'Continuous integration' section, there is a row for 'AgileSummit2022' which is currently 'Disabled'. To the right of this row, there is a checkbox labeled 'Enable continuous integration' which is currently unchecked. This checkbox is highlighted with a red rectangle.

CONTINUOUS INTEGRATION (5)

- Save & queue 選取 Save。
- 只要 Azure DevOps 的 AgileSummit2022 Repository 有更新，就會自動觸發。

The screenshot shows the Azure DevOps Pipelines interface for the 'AgileSummit2022' repository. On the left, there's a sidebar with navigation links: Overview, Boards, Repos, Pipelines (which is selected and highlighted in grey), Environments, Releases, Library, and Task groups. The main area displays a pipeline named 'AgileSummit2022-CI'. The 'Triggers' tab is active, showing a 'Continuous integration' section with a single trigger named 'AgileSummit2022' which is 'Enabled'. Below this, there are sections for 'Scheduled' (No builds scheduled) and 'Build completion' (Build when another build completes). At the top right, there's a 'Save & queue' button with a dropdown menu. The 'Save' option in this menu is highlighted with a red box. To the right of the pipeline details, there are configuration sections for 'Branch filters' (Type: Include, Branch specification: main) and 'Path filters'.

CONTINUOUS INTEGRATION (6)

The screenshot shows the Azure DevOps interface for a repository named 'AgileSummit2022'. The left sidebar is a navigation menu with the following items:

- Azure DevOps
- AgileSummit2022
- Overview
- Boards
- Repos** (selected)
- Files
- Commits
- Pushes
- Branches

The main content area displays the contents of the 'main' branch of the 'AgileSummit2022' repository. The 'README.md' file is selected. The file content is as follows:

```
Agile Summit 2022
Sample code comes from Azure Machine Learning Python SDK v2 \(preview\).
Training data comes from Iris in Azure Example Datasets.
Updated for testing at 09:59.
```

At the bottom right of the file view, there is a button labeled 'Create a pull request'.

CONTINUOUS INTEGRATION (7)

The screenshot shows the Azure DevOps Pipelines interface for the project "AgileSummit2022". The left sidebar navigation bar is visible, with "Pipelines" selected. The main content area displays the "Runs" tab for the "AgileSummit2022-CI" pipeline. Three recent runs are listed:

Description	Stages	Time
#3 Updated README.md ↳ Individual CI for ✘ main ↳ 8623af92	⌚	Just now ⌚ 4s
#2 Added install.sh to / ↳ Manually triggered for ✘ main ↳ c4b9b3b0 ✘	✓	9h ago ⌚ 53s
#1 Added install.sh to / ↳ Manually triggered for ✘ main ↳ c4b9b3b0 ✘	✓	9h ago ⌚ 1m 10s

CONTINUOUS INTEGRATION (8)

← [Build succeeded] AgileSummit2022-CI - AgileSummit2022:main - AgileSummit2022 - 8623af92

Azure DevOps To: KC Su

Microsoft Azure DevOps

Mon 8/29/2022 10:01 AM

BUILD #3 SUCCEEDED

AgileSummit2022-CI

Ran for 65 seconds

[View results](#)

Summary

Build pipeline	AgileSummit2022-CI
Finished	Mon, Aug 29 2022 02:00:42 GMT+00:00
Requested for	KC Su
Reason	Continuous integration

THANK YOU