

Guidance

Access to Azure Lab

[Download Remote Desktop App to connect your Azure VM](#)

[Getting it for Mac](#)

[Getting it for Windows](#)

[Start Azure VM](#)

IntelliJ IDE

[Start an new Python project](#)

[To install a Python dependency package](#)

[Dependencies Needed in Course](#)

Ubuntu VMs

[To start Ubuntu VMs](#)

[Ubuntu VM's IP](#)

[To get Ubuntu VM's IP address](#)

[SSH to Ubuntu VMs](#)

Prepare necessary environment for Ubuntu VMs

[Python 3](#)

[Docker-compose tool](#)

Transfer files with VMs

[By MobaXterm \(Recommended\)](#)

[By shared folder \(Not Recommended\)](#)

How to write a docker-compose configuration file

How to build your code into docker image

[Prepare a Dockerfile](#)

[Prepare a docker-compose configuration file](#)

[Execution flow](#)

Coursework supplements

[Overview structures](#)

[Task 1](#)

[Task 2](#)

[Task 3](#)

Implementation Examples

[How to send HTTP request to get sensor data](#)

[How to define MQTT subscriber in Python](#)

[How to define MQTT publisher in Python](#)

[How to define RabbitMQ consumer in Python](#)

[How to define RabbitMQ producer in Python](#)

[How to use Matplotlib to visualize a line chart](#)

[How to use Machine Learning Engine](#)

Problems

[Docker logs cannot print output](#)

[An error occurred while attempting to start VM](#)

Appendix

[About target sensors information](#)

For Demonstrators

Access to Azure Lab

You can access to Azure Lab both in campus or out of campus.

Every student has admin privileges for Windows and Ubuntu, which means you can install any software you need.

Download Remote Desktop App to connect your Azure VM

If you are not using university's desktop, please download this App by yourself ! Otherwise, you could login VM in Azure Lab directly by downloading access file.

Getting it for Mac

App Store:  Microsoft Remote Desktop

Mac App Store Preview

Open the Mac App Store to buy and download apps.



Microsoft Remote Desktop 4.4

Work from anywhere
Microsoft Corporation

★★★★★ 4.4 • 16.6K Ratings

Free

[View in Mac App Store](#)

Screenshots



Use Microsoft Remote Desktop for Mac to connect to Azure Virtual Desktop, Windows 365, admin-provided virtual apps and desktops, or remote PCs. With Microsoft Remote Desktop, you can be productive no matter where you are.

[GET STARTED](#) [more](#)

[Version History](#)

Getting it for Windows

Microsoft Store:  [Get \\$Microsoft Remote Desktop from the Microsoft Store](#)

Microsoft Windows Apps Software Games & Entertainment All Microsoft

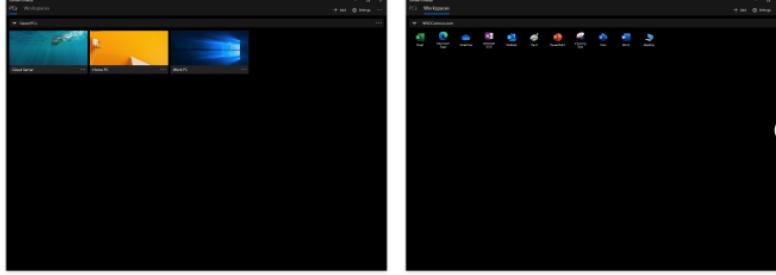
Developers Sign in



Microsoft Remote Desktop
Microsoft Corporation

★★★★☆ 665 | Productivity

[Get in Store app](#) [Free](#)



Details
Available in 110 languages
Published by Microsoft Corporation
Terms Privacy policy
Developer and IT App badge Endpoint Manager

 PEGI 3

Description

Use the Microsoft Remote Desktop app to connect to a remote PC or virtual apps and desktops made available by your admin. The app helps you be productive no matter where you are.

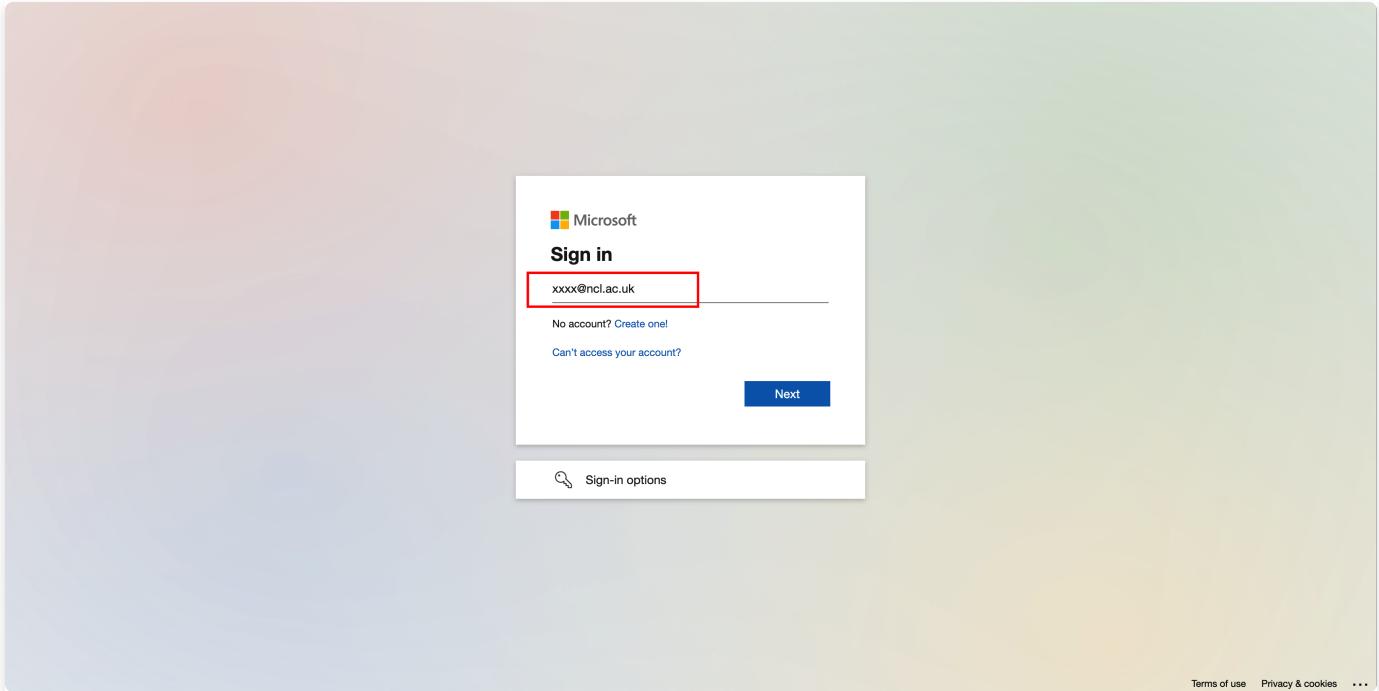
Getting Started
Configure your PC for remote access first. Download the Remote Desktop assistant to your PC and let it do the work for you: [https://aka.ms/RDSetup...](https://aka.ms/RDSetup)

[Read more](#)

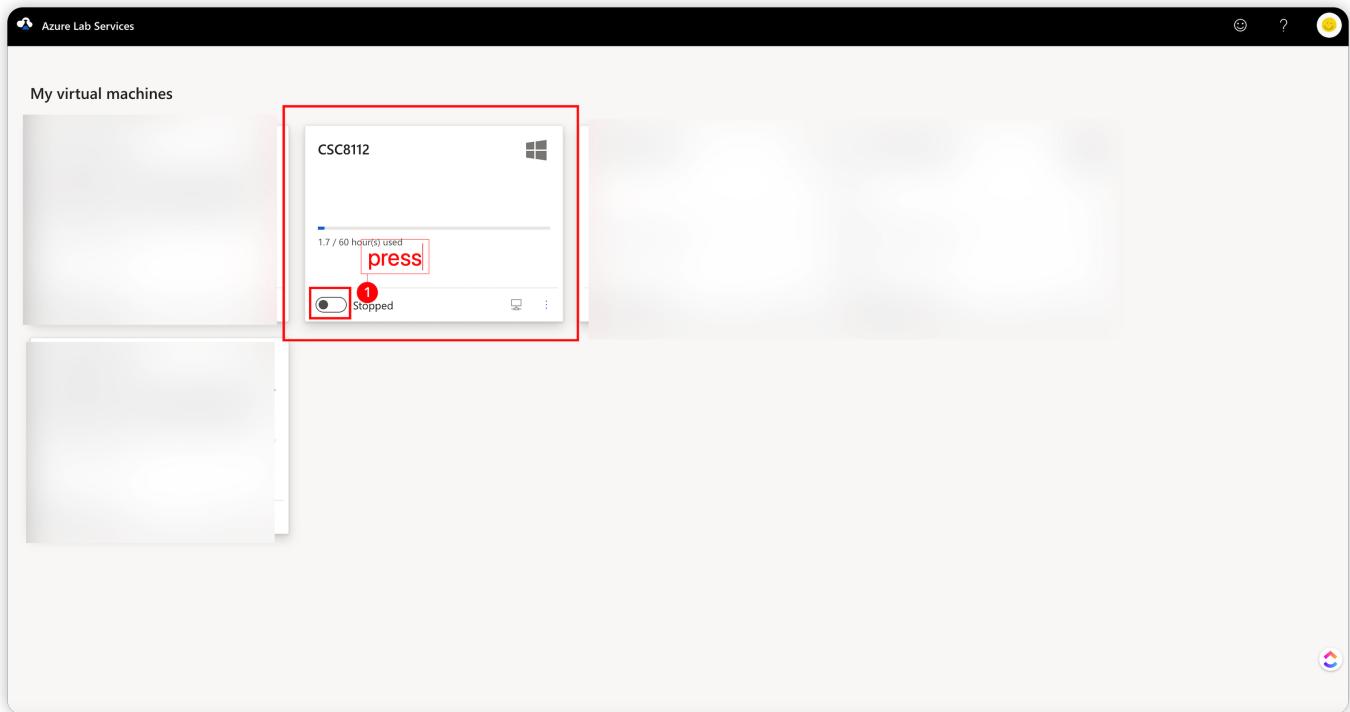
Start Azure VM

1. Go to:  [Azure Lab Services](#)

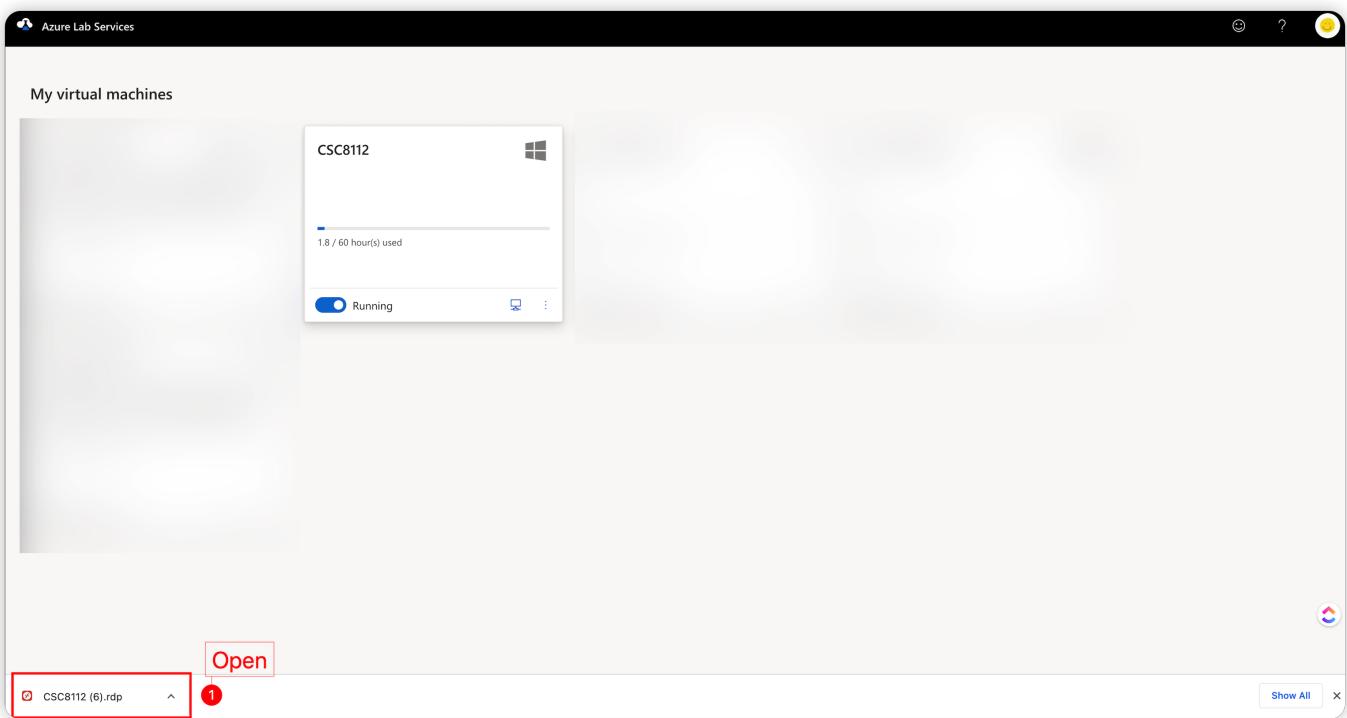
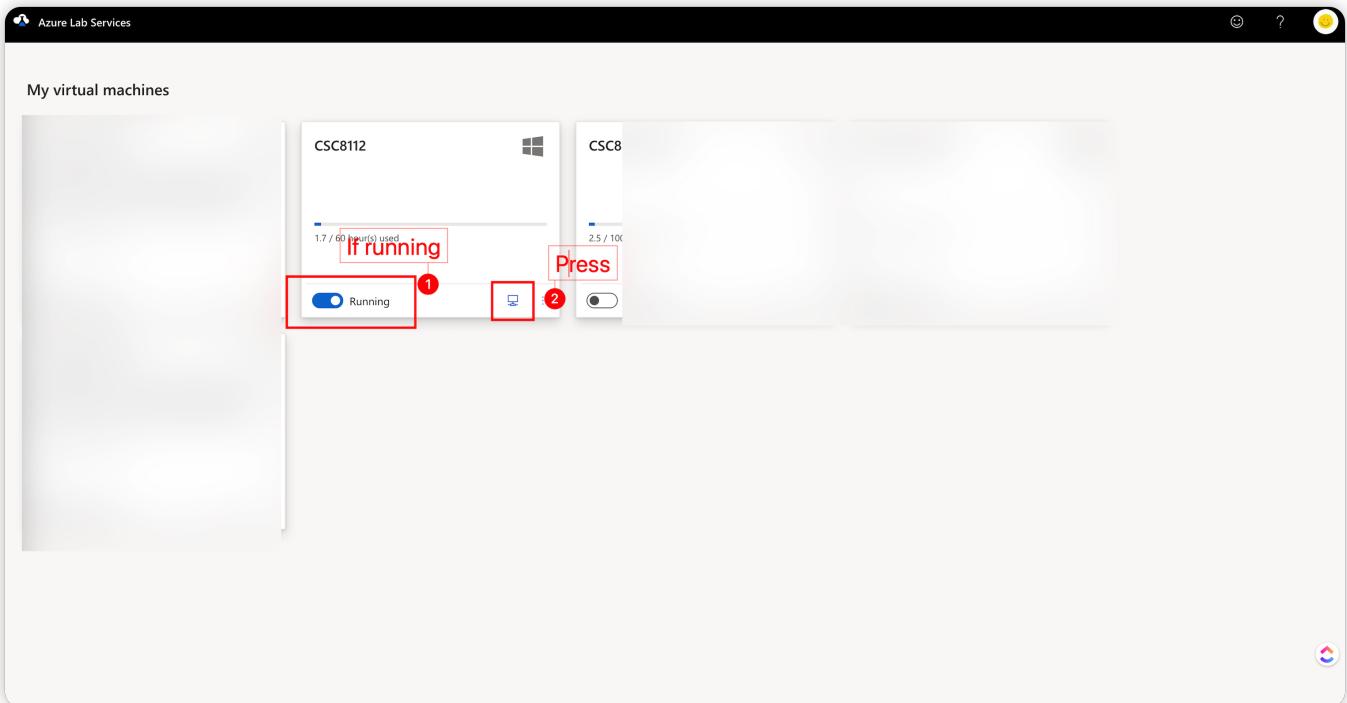
2. Login with your University account



3. Start your VM

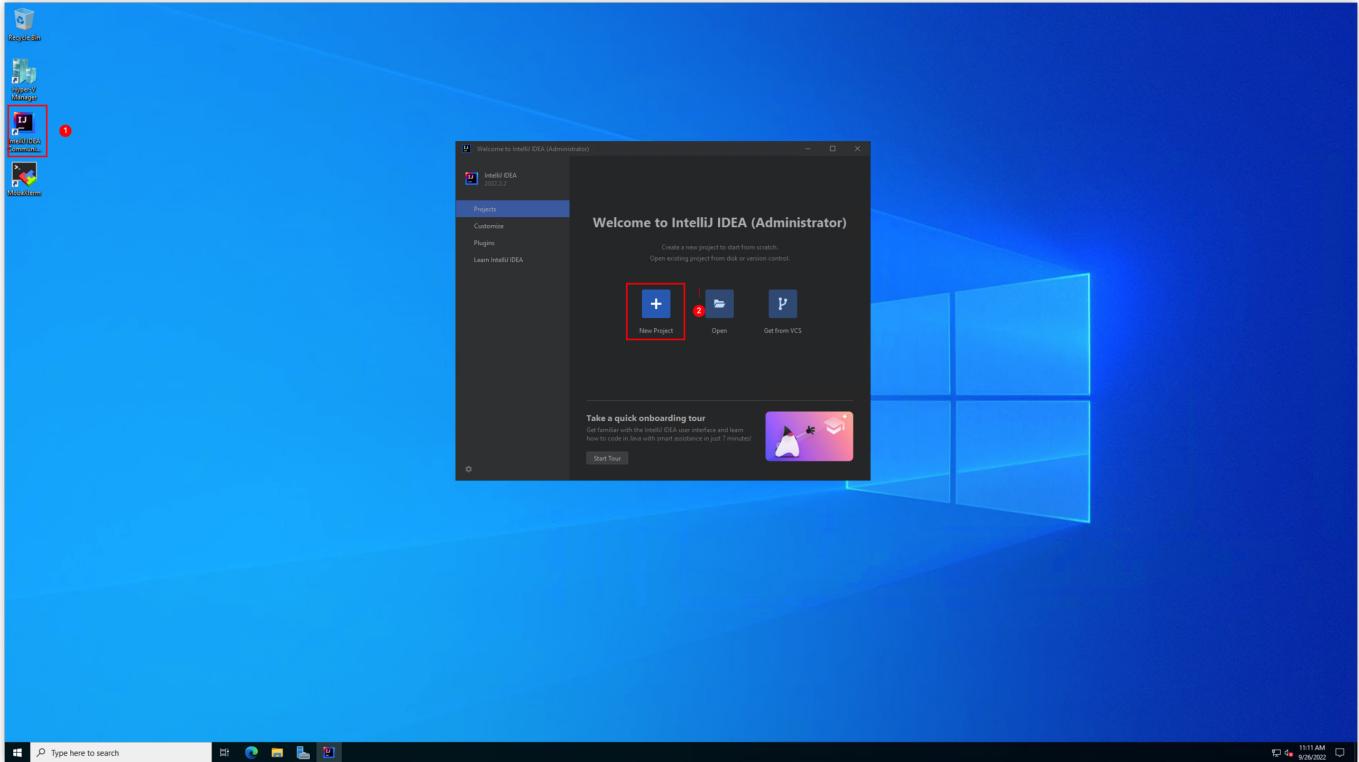


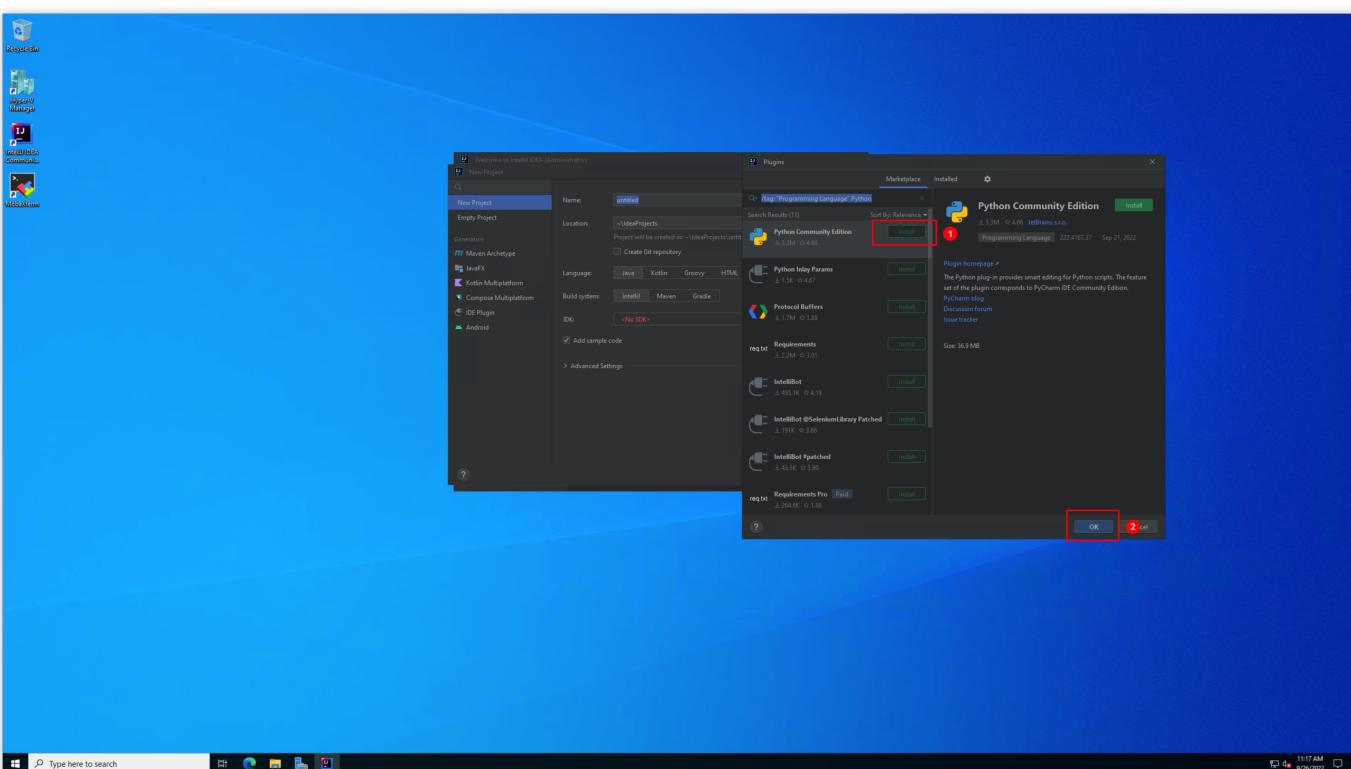
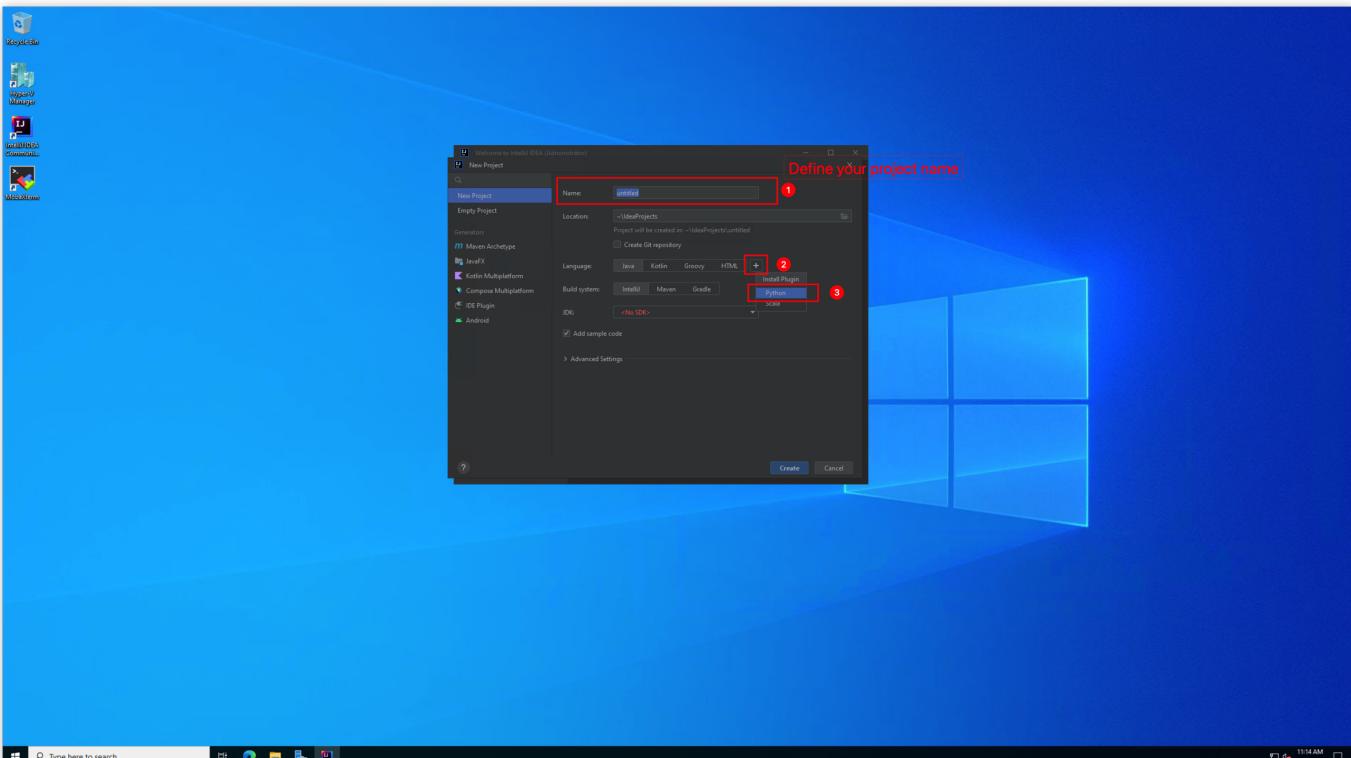
4. Connect your VM with password (Please check it in Teams channel)

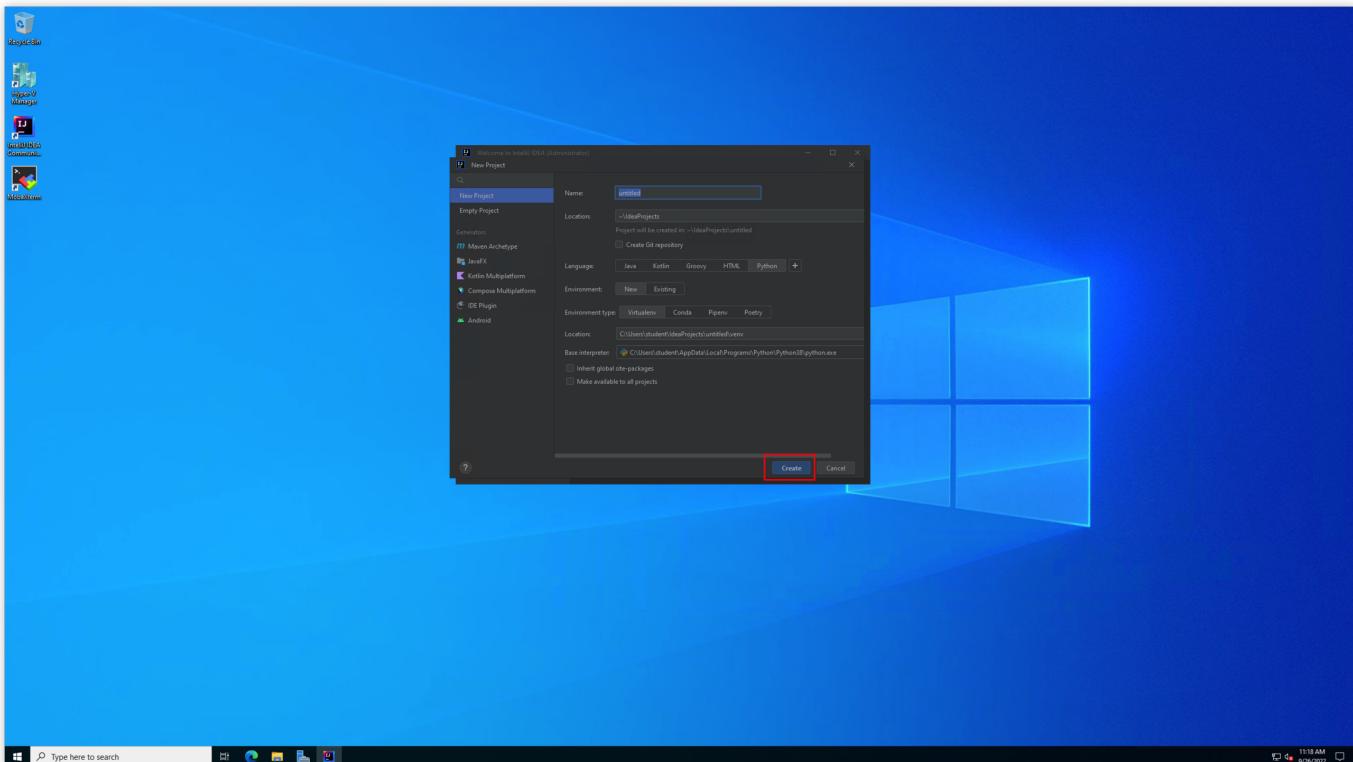


IntelliJ IDE

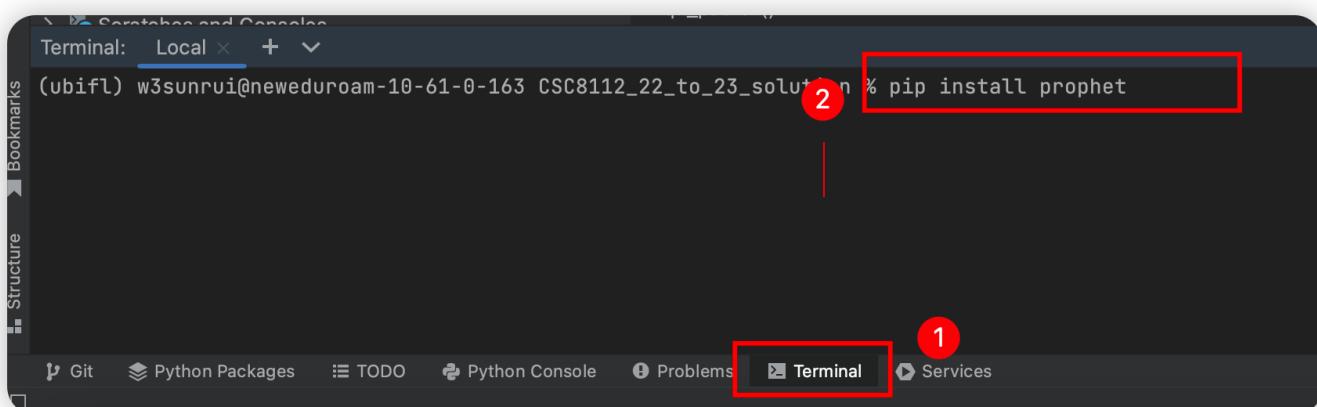
Start an new Python project







To install a Python dependency package



Dependencies Needed in Course

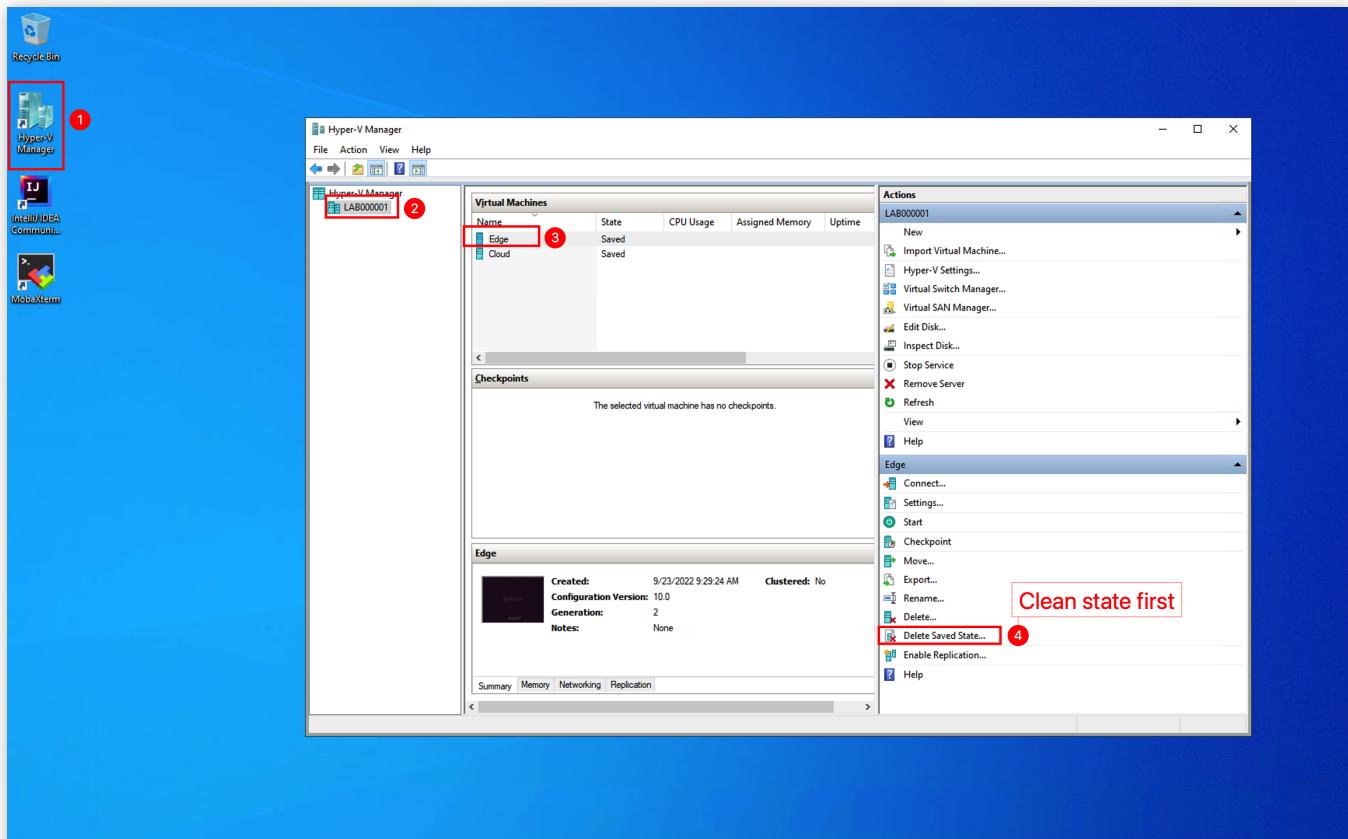
Package Name	Version (== or latest)	Install Command	Task
requests	2.28.1	pip install requests	1
paho.mqtt	1.6.1	pip install paho-mqtt	1 & 2

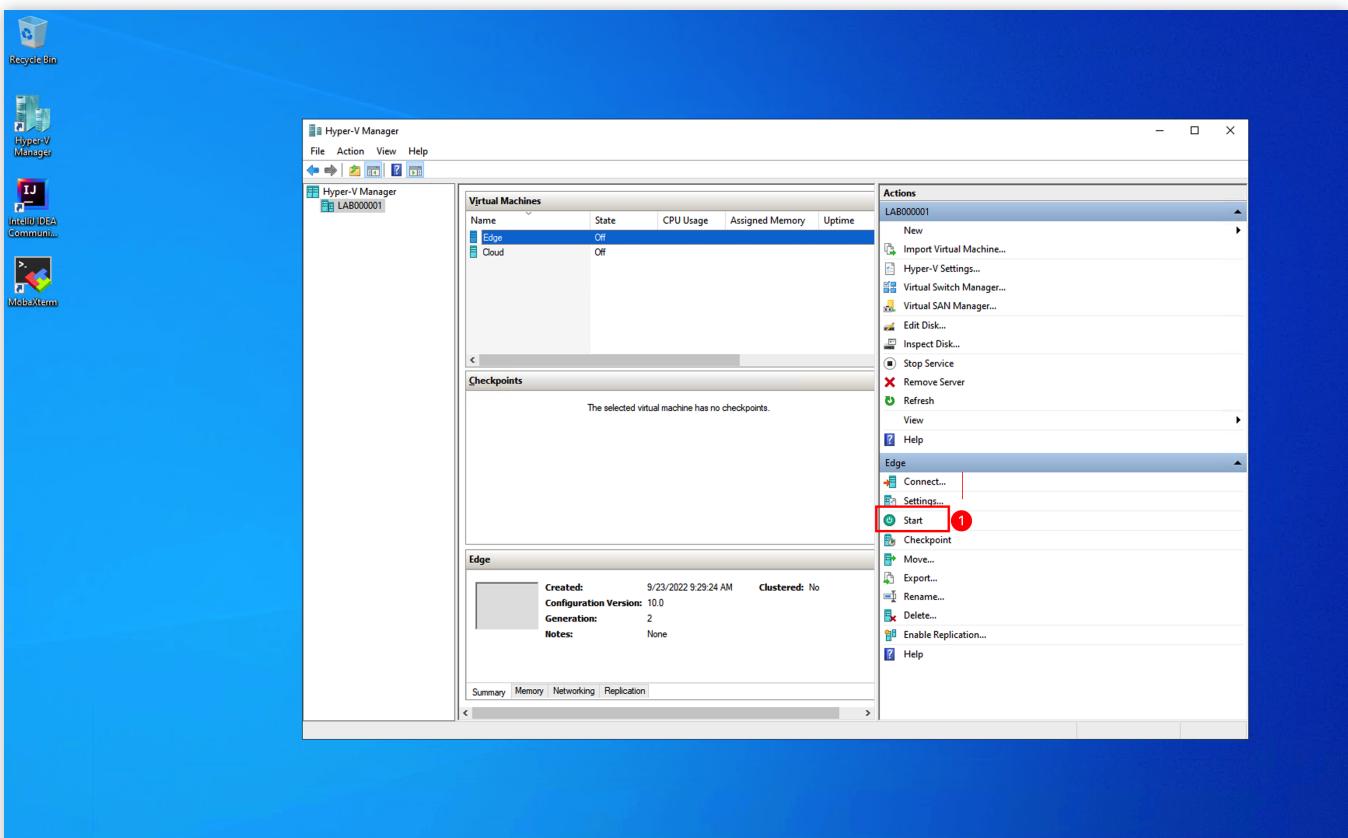
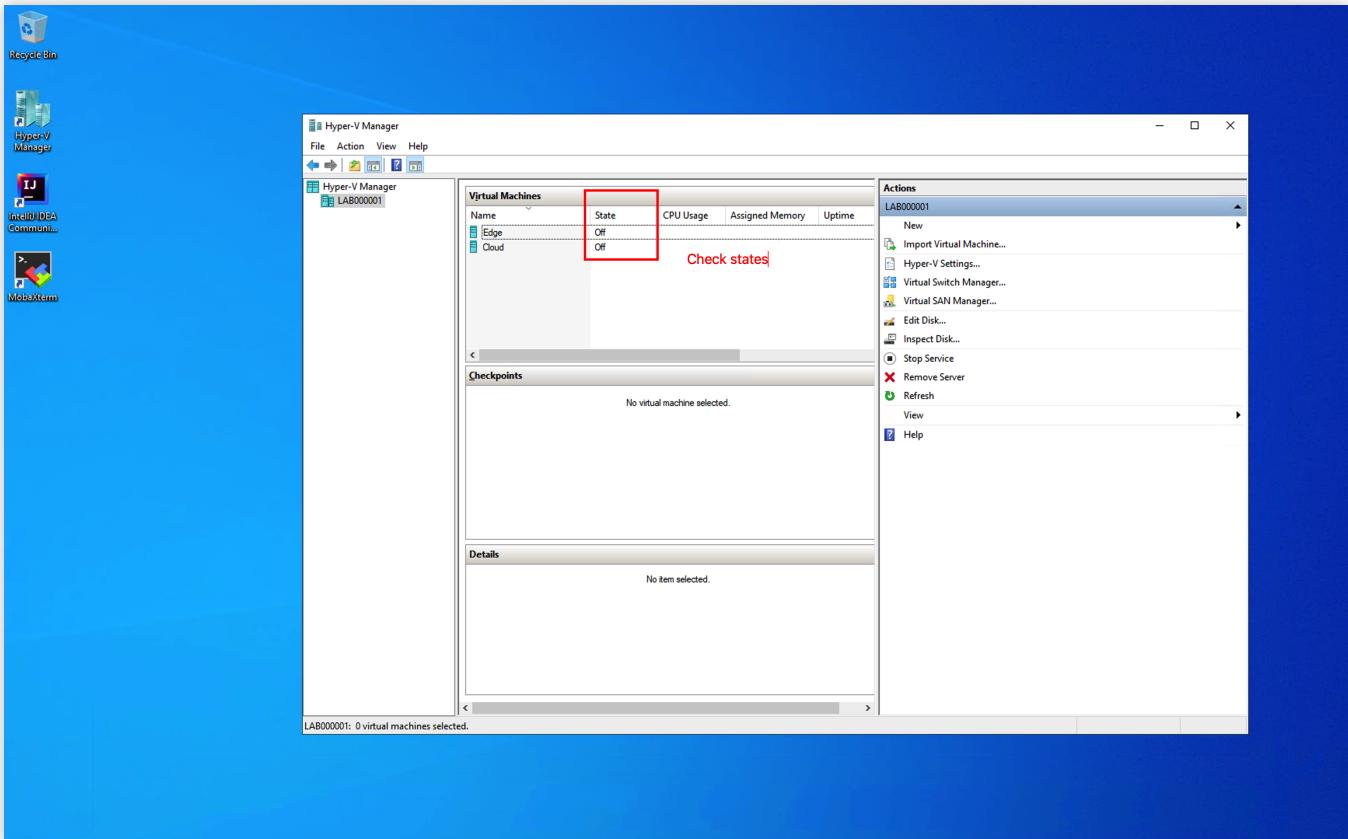
pika	1.3.0	python -m pip install pika --upgrade	2 & 3
prophet	1.1.1	python -m pip install prophet	3
matplotlib	3.6.0	pip install matplotlib	3

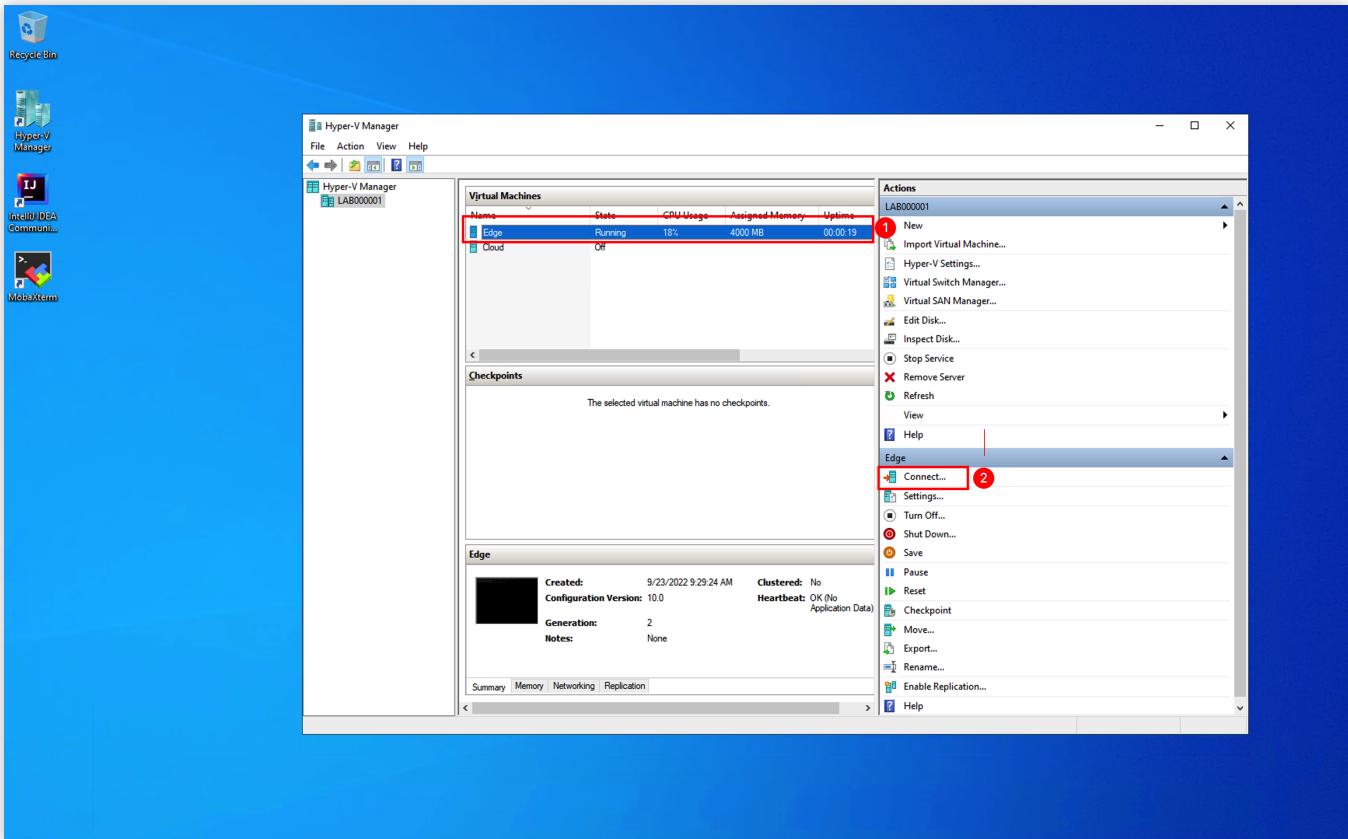
Ubuntu VMs

To start Ubuntu VMs

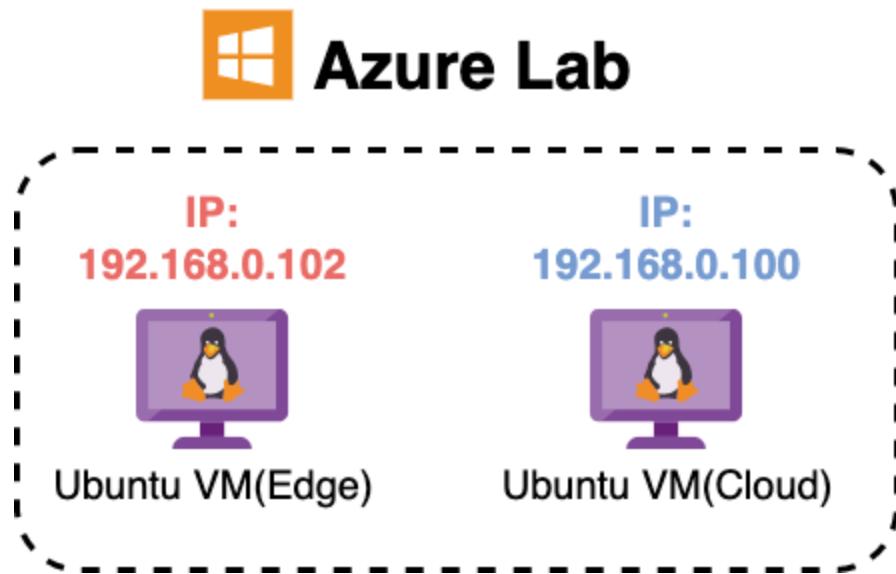
For the first time using, please clean saved state first (both Edge and Cloud), according to the following screenshot !



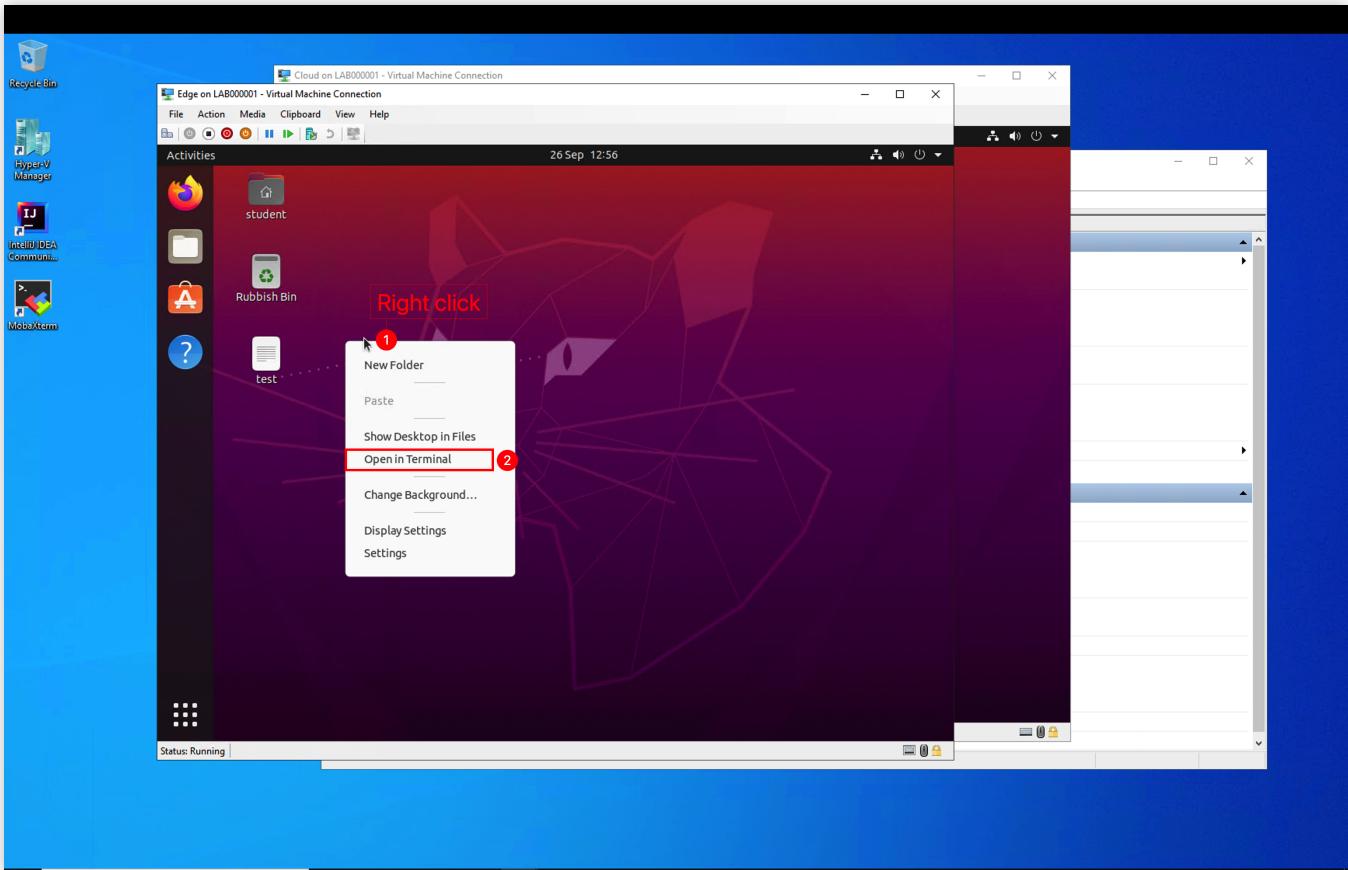




Ubuntu VM's IP

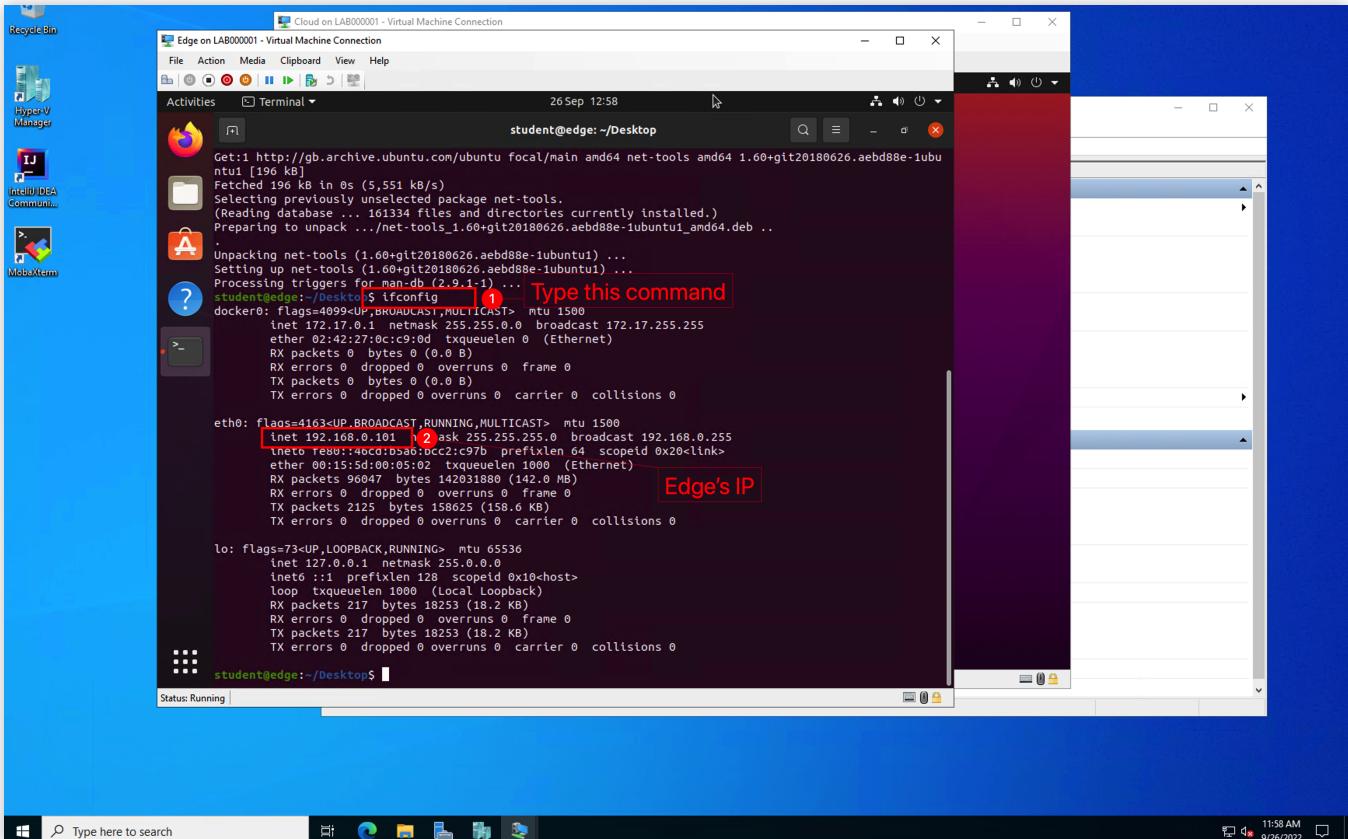


To get Ubuntu VM's IP address



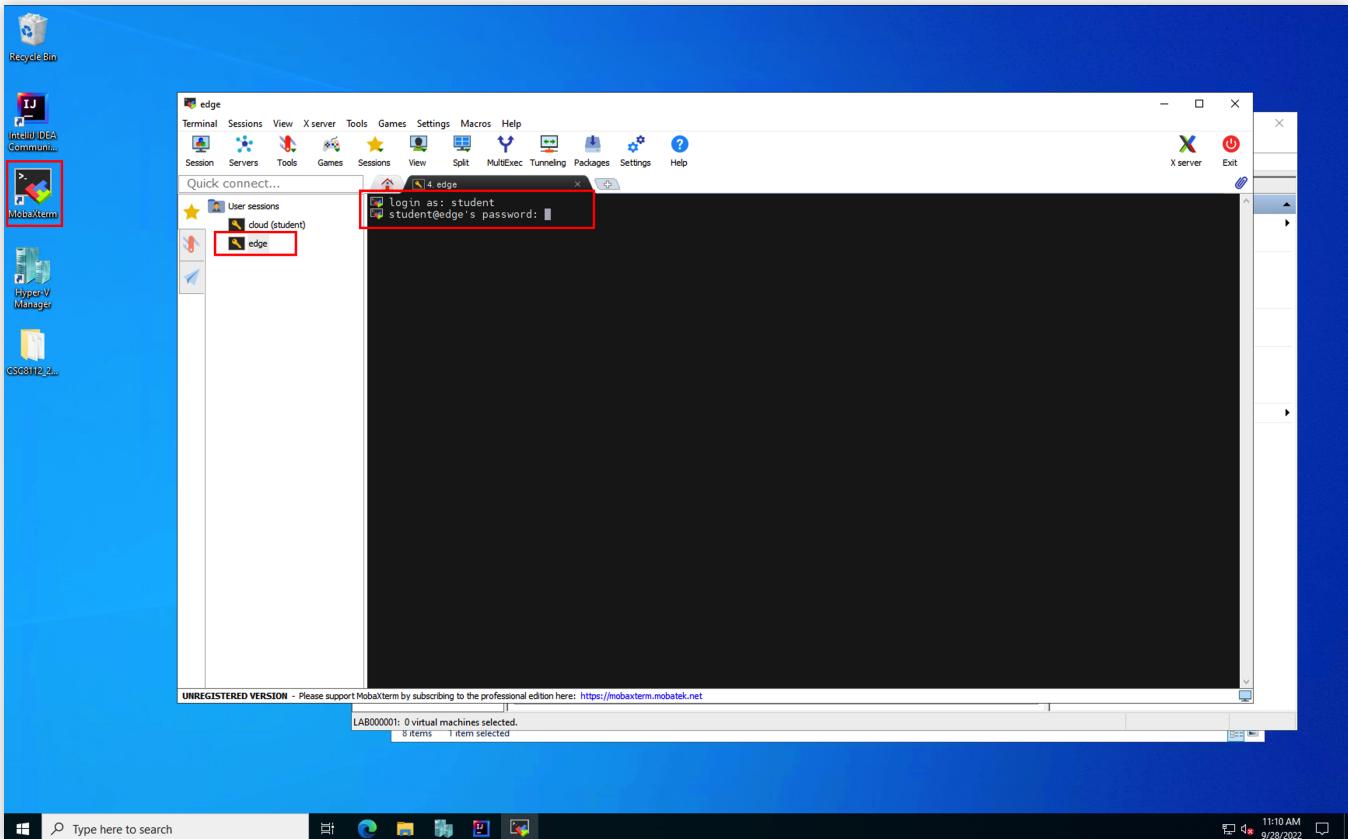
Install net-tools to system

```
▼ Install net-tools                                Bash |  
sudo apt install net-tools
```



SSH to Ubuntu VMs

The Azure VM provided "MobaXterm" to let you easily connect Ubuntu VMs by terminal way.



Prepare necessary environment for Ubuntu VMs

Python 3

Please manually install Python3.8 and pip in both Ubuntu VMs.

```
▼ Install Python 3.8 and Pip                               Shell |  
1 sudo apt install python3  
2  
3 sudo apt install python3-pip
```

Docker-compose tool

Please manually install docker-compose tool in both Ubuntu VMs.

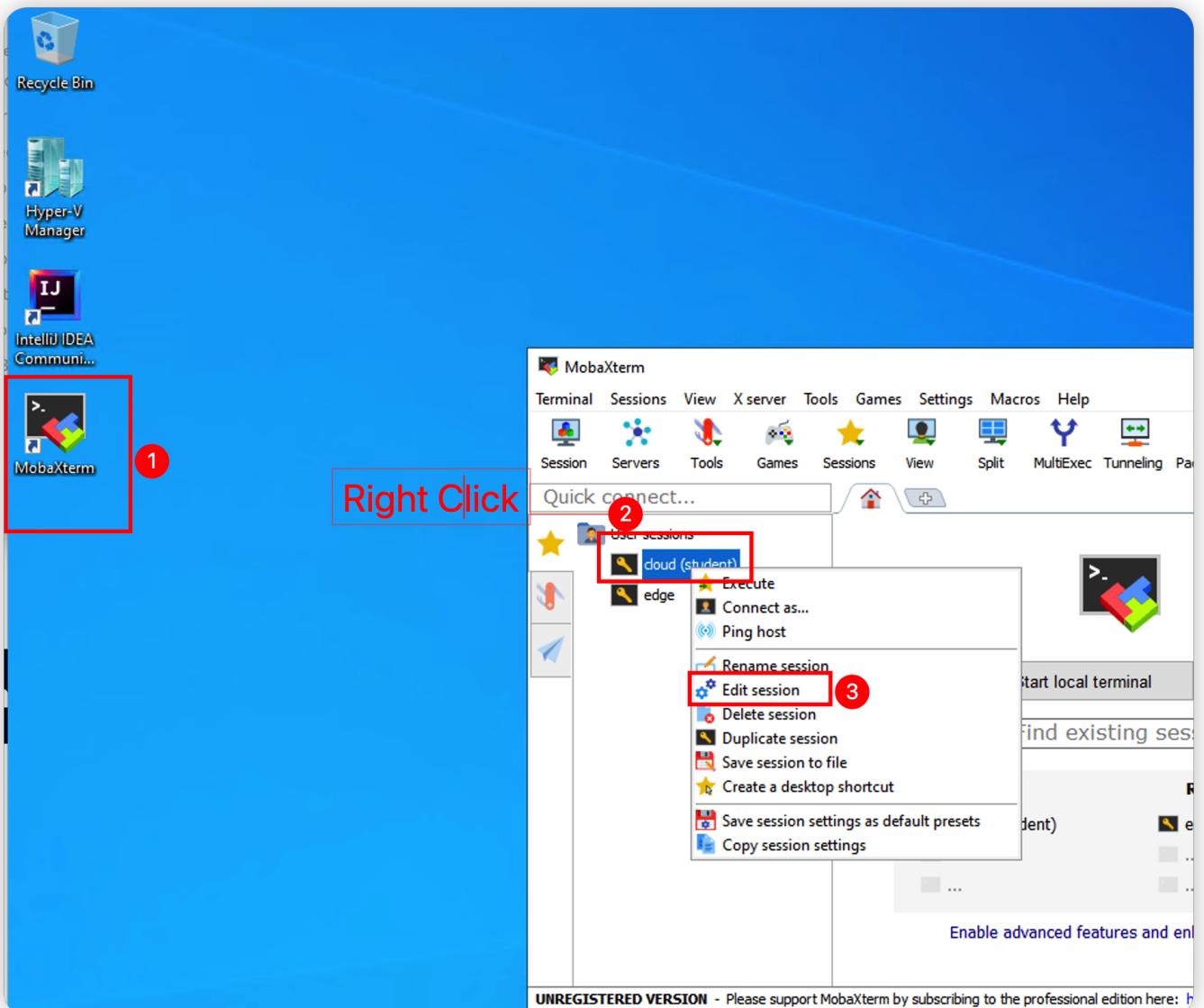
```
▼ Install docker-compose tool                             Shell |  
1 sudo apt install docker-compose
```

Transfer files with VMs

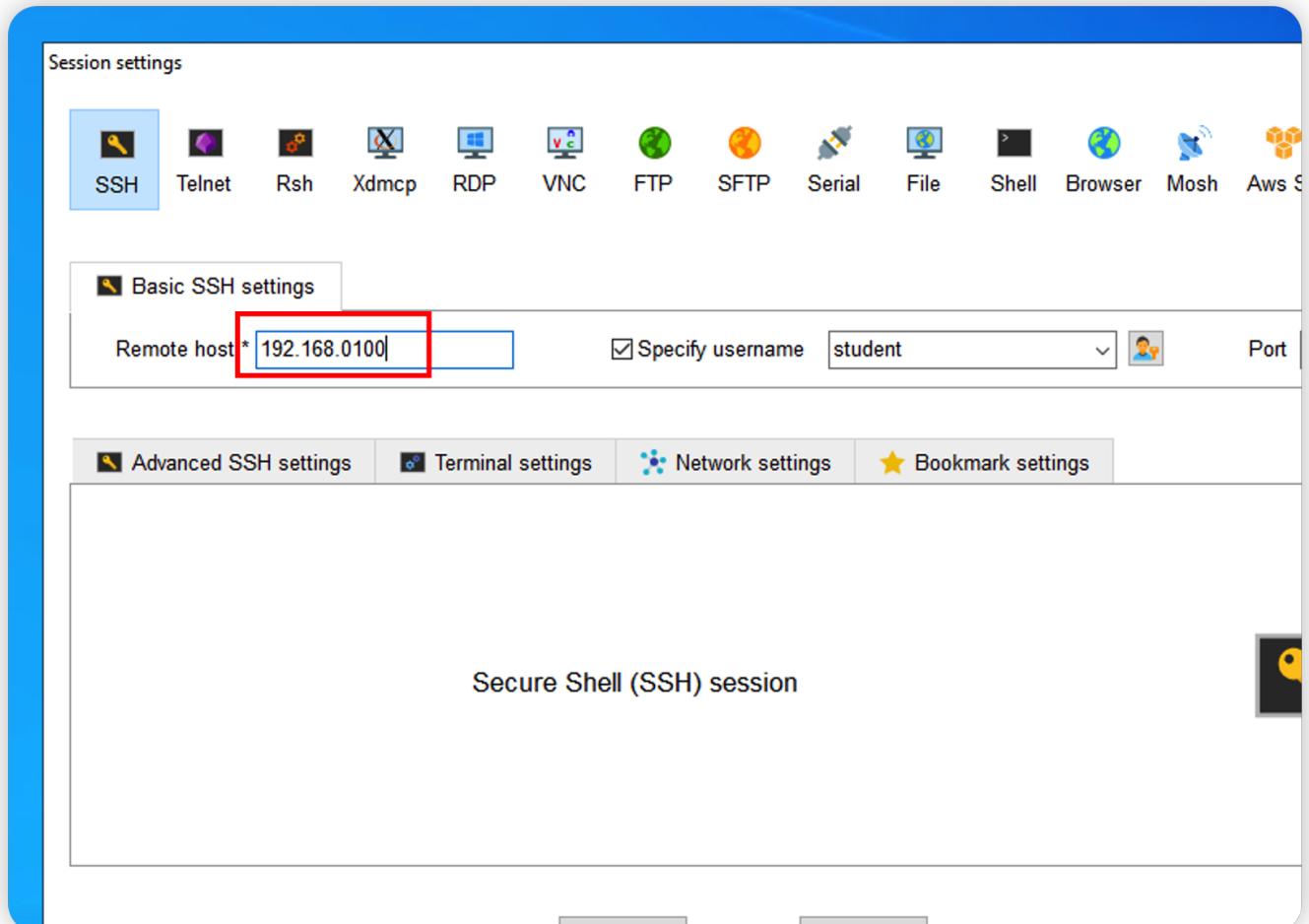
By MobaXterm (Recommended)

If you are using ModeXterm, pls do the following operation first !

Otherwise the old configuration may refer to the same VM while you are trying to login.



Setting for Cloud



Setting for Edge

Session settings



Basic SSH settings

Remote host *

Specify username

Advanced SSH settings

Terminal settings

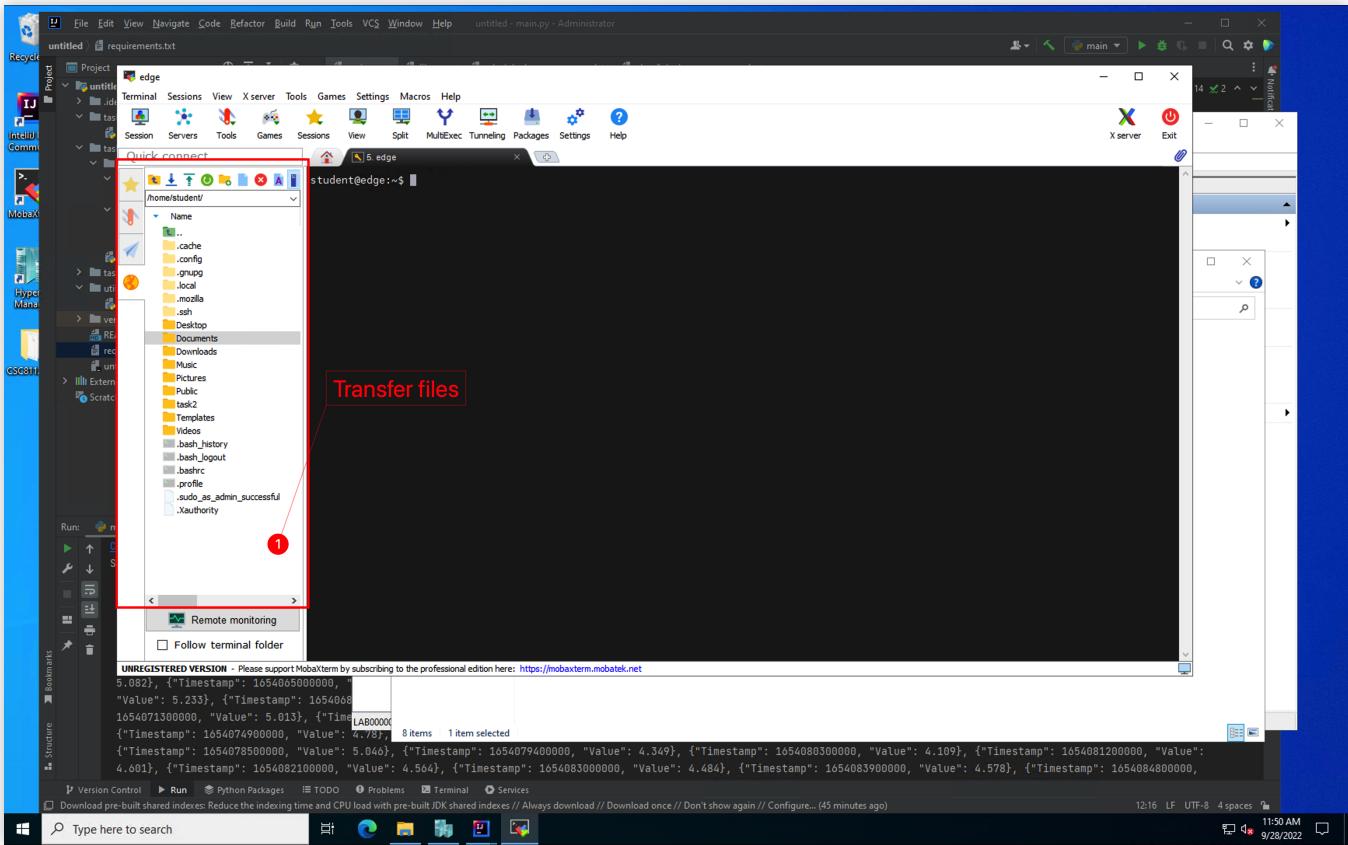
Network settings

Bookmarks

Secure Shell (SSH) session

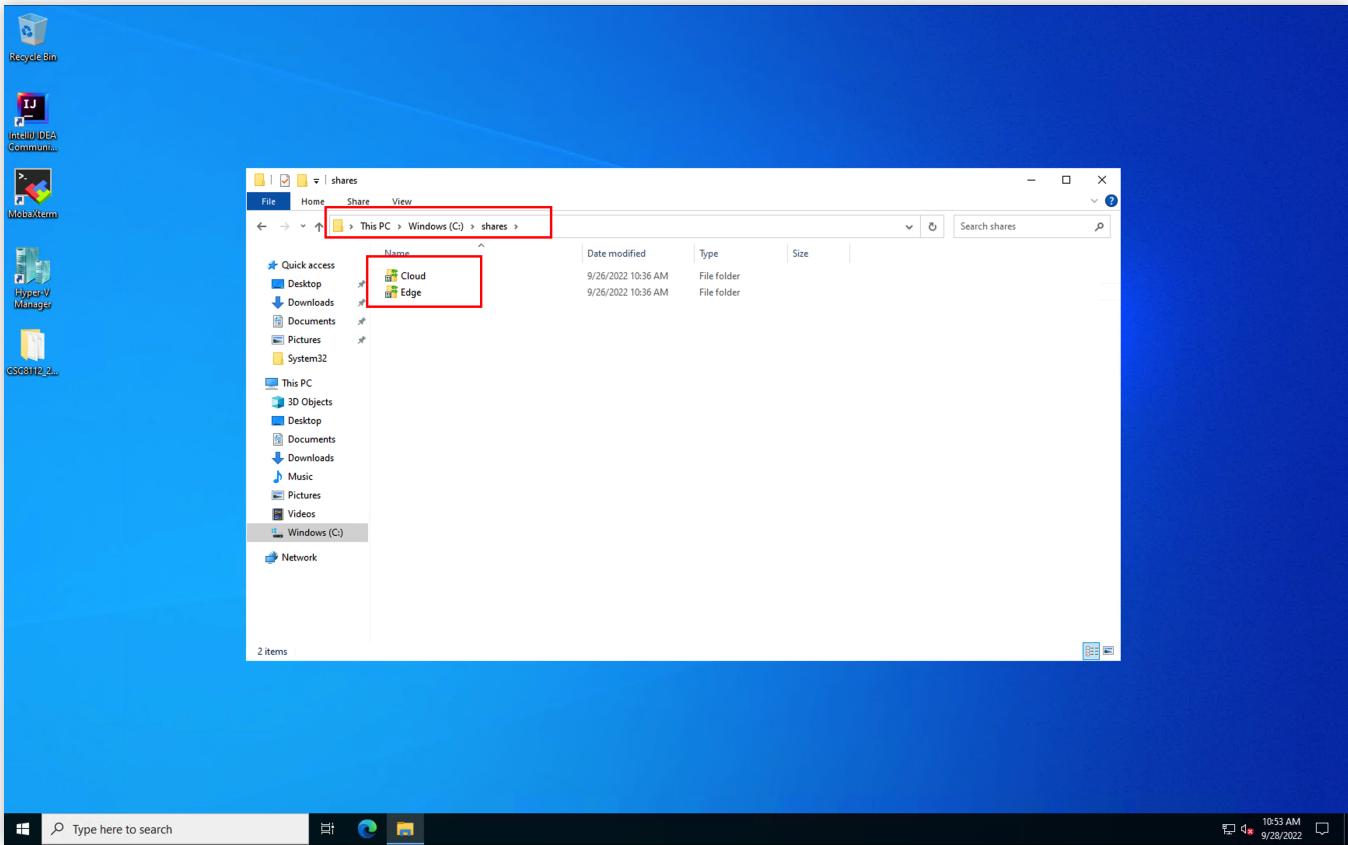
OK

Cancel



By shared folder (Not Recommended)

We provide two shared directories for Cloud and Edge respectively.



How to write a docker-compose configuration file

Hint: Refer the docker-compose.yml file in [Use Docker Compose](#)

Example:

```
▼ docker-compose file example                               YAML |  
1 version: "3"  
2 services:  
3   mongo:  
4     image: mongo  
5     deploy:  
6       replicas: 1  
7     ports:  
8       - '27017:27017'
```

How to build your code into docker image

Prepare a Dockerfile

Example:

```
▼ Dockerfile Dockerfile |  
1 # Base on image_full_name (e.g., ubuntu:18.04) docker image  
2 FROM python:3.8.12  
3  
4 # Switch to root  
5 USER root  
6  
7 # Copy all sources files to workdir  
8 ADD <your project directory> /usr/local/source  
9  
10 # Change working dir  
11 WORKDIR /usr/local/source  
12  
13 # Prepare project required running system environments  
14 # requirements.txt is a document that pre-define any  
15 # python dependencies with versions required of your code  
16 RUN pip3 install -r requirements.txt  
17  
18 # Start task  
19 CMD python3 <your main .py file>
```

Prepare a docker-compose configuration file

```
▼ docker-compose configuration file YAML |  
1 version: "3"  
2 services:  
3   data_injector:  
4     image: data_injector:latest
```

Execution flow

1. Run your Dockerfile file first with command:

```
▼ Build code Shell |  
1 sudo docker build -t <name:tag> <source directory (relative)>
```

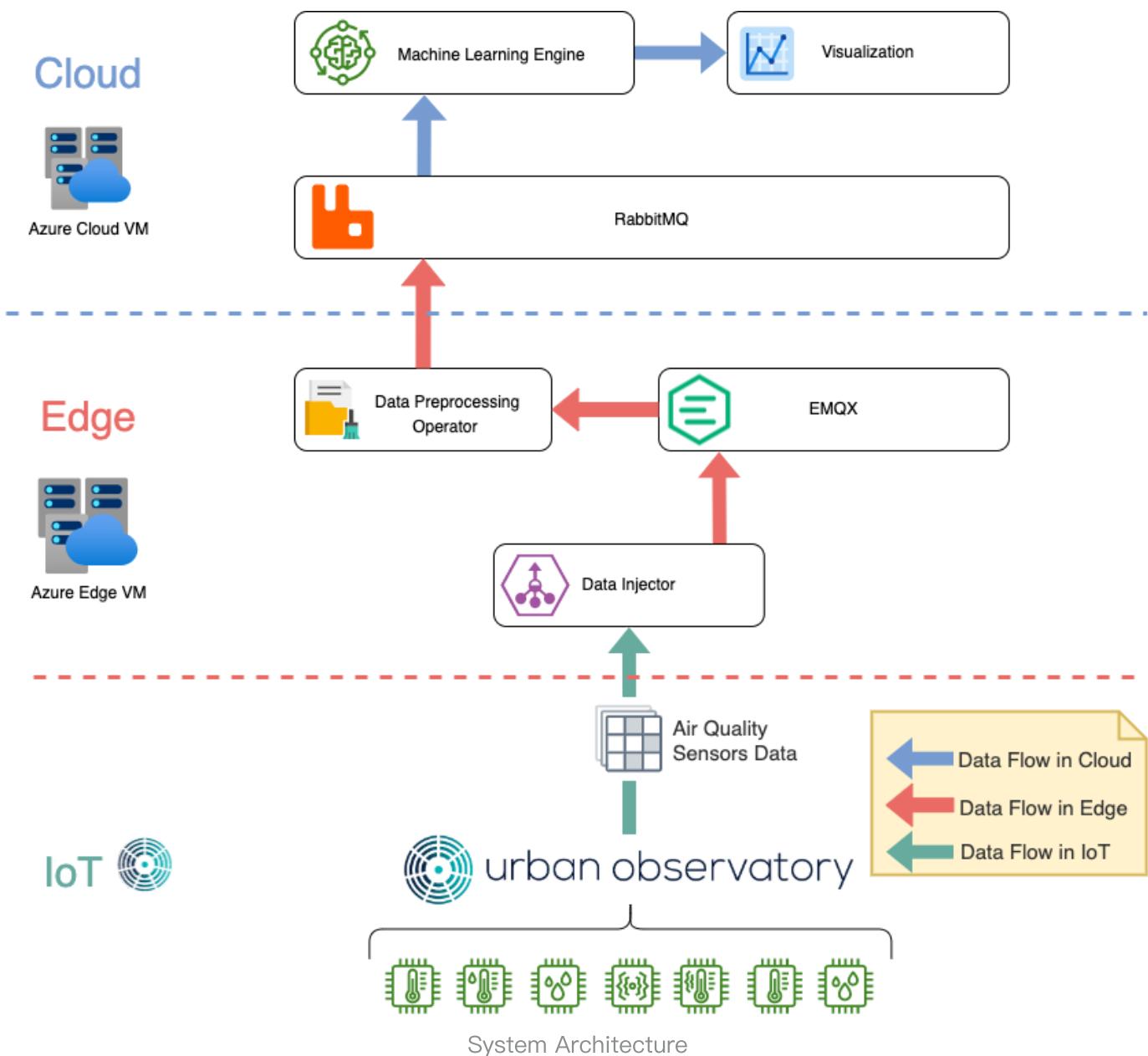
2. Run your docker-compose file with command:

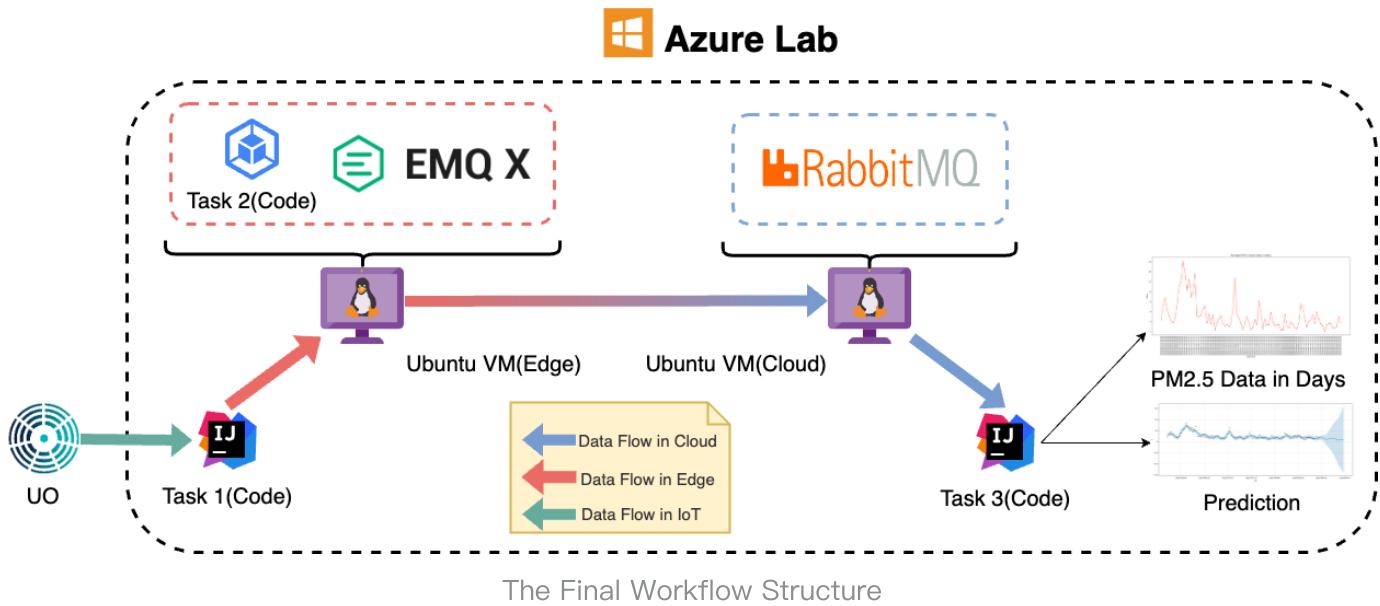
- Please make sure the docker-compose tool already installed, if not, please refer to chapter [Docker-compose tool](#)

```
▼ Start a image | Shell |  
1 sudo docker-compose up
```

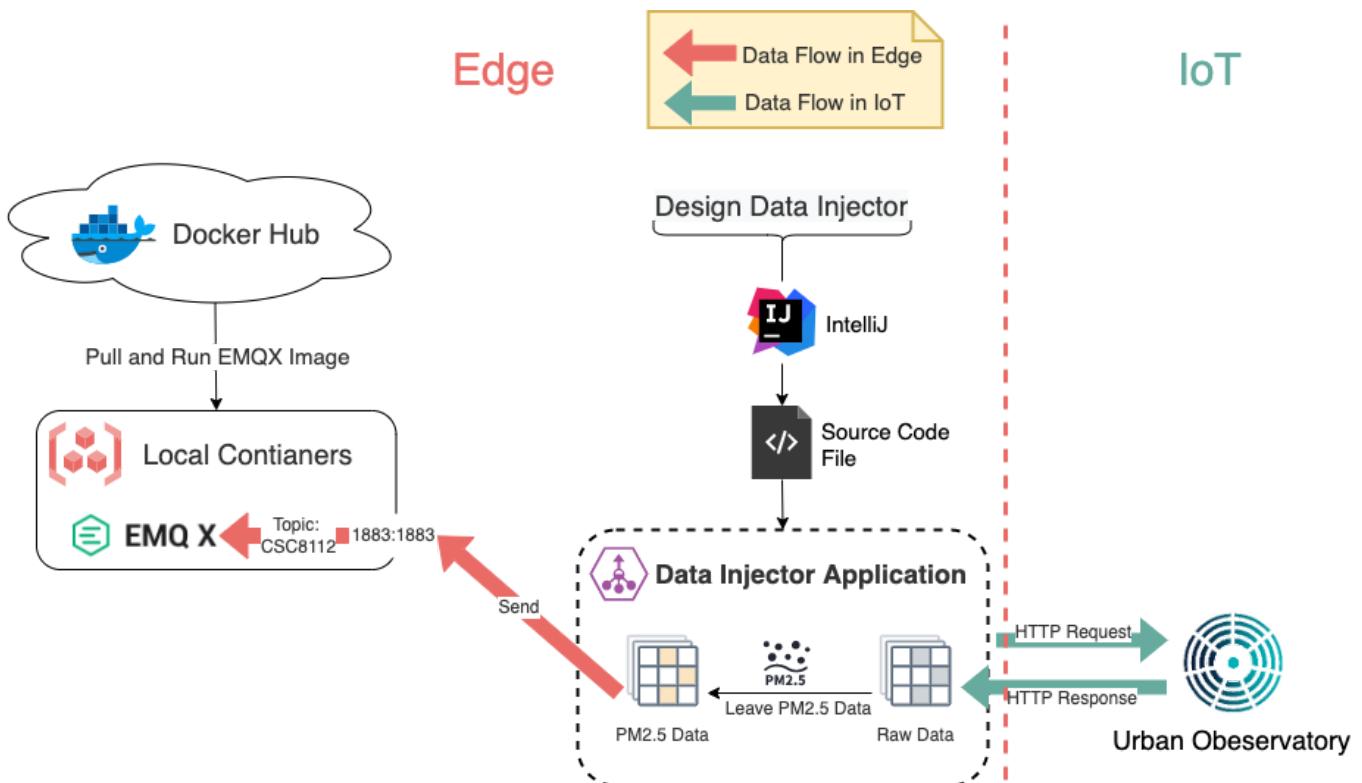
Coursework supplements

Overview structures



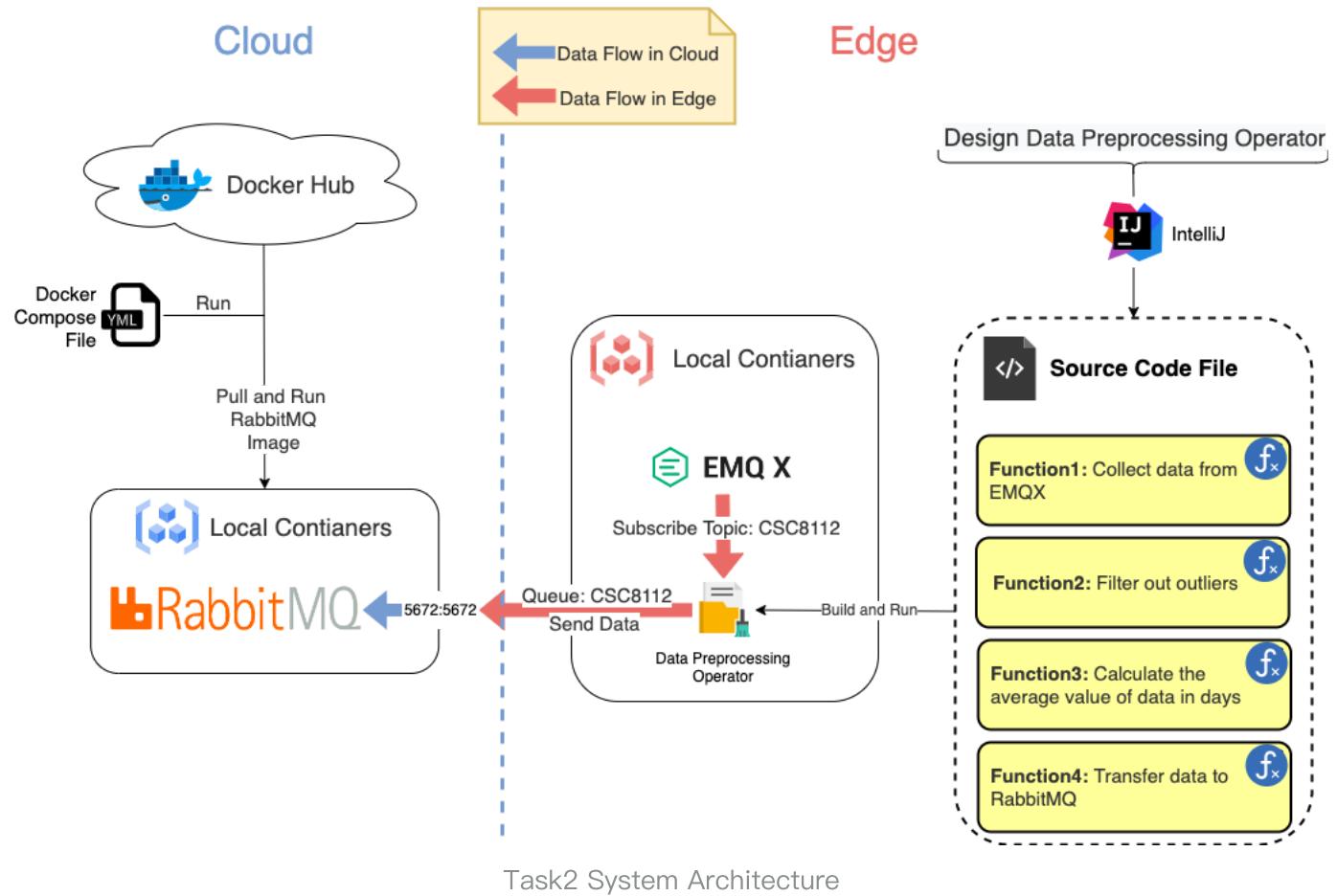


Task 1

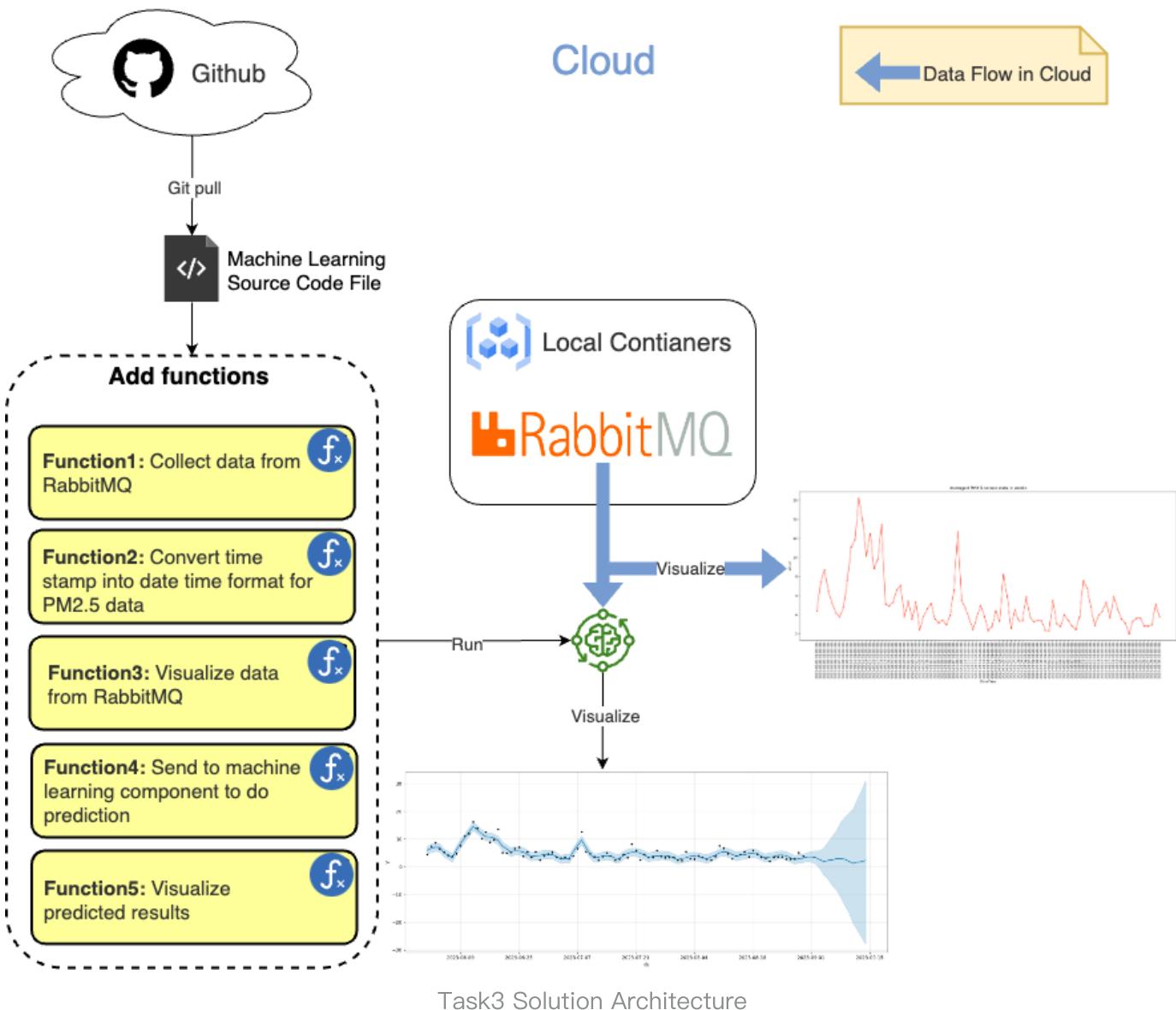


Task1 System Architecture

Task 2



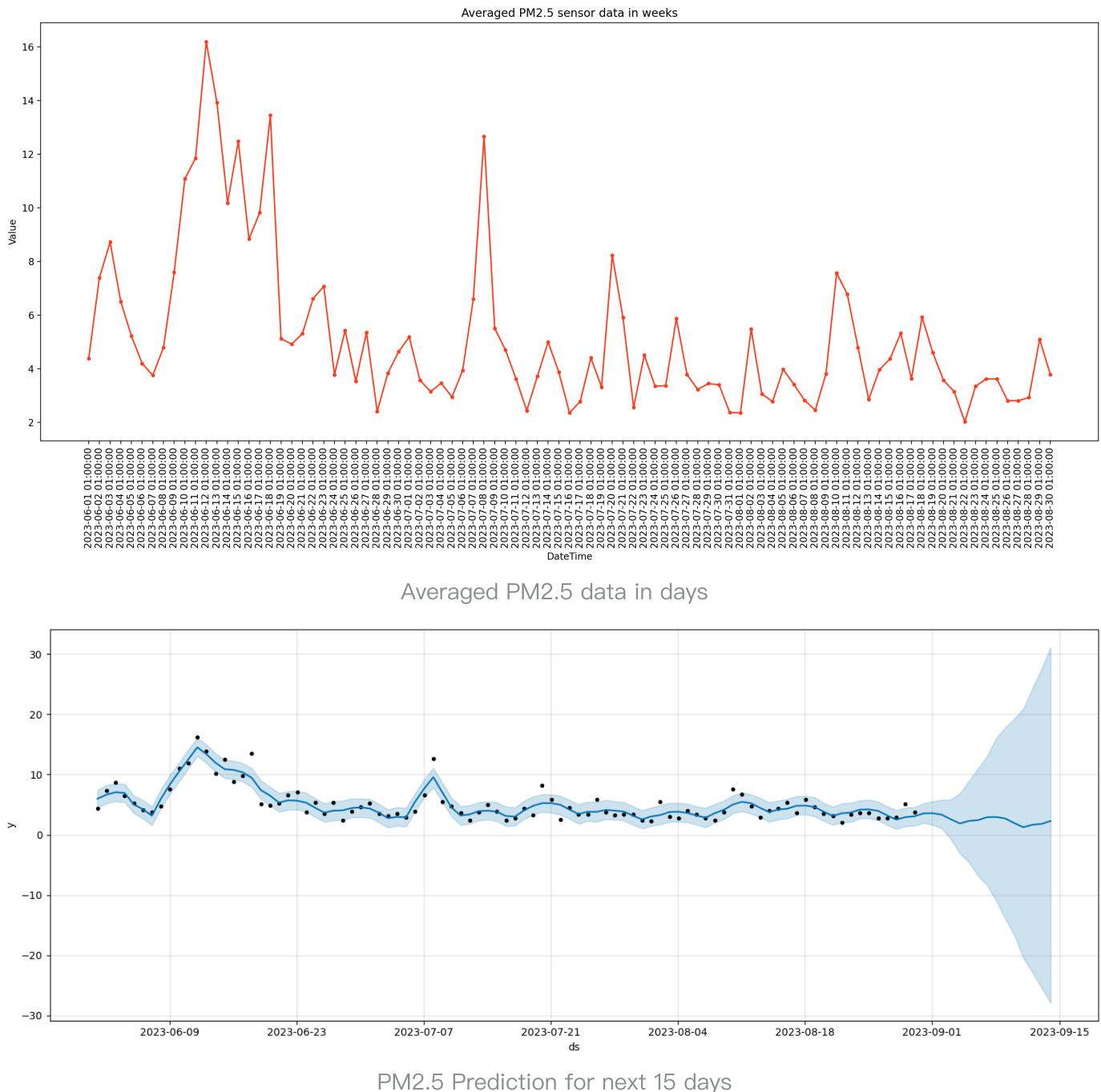
Task 3



Task3 Solution Architecture

Download Machine Learning engine code: [GitHub – ncl-iot-team/CSC8112_MLEngine](https://github.com/ncl-iot-team/CSC8112_MLEngine)

The final results in visualization look like this:



Implementation Examples

How to send HTTP request to get sensor data

▼ HTTP Get

Python |

```
1 import requests
2
3 if __name__ == '__main__':
4     # Target URL
5     url = "http://uoweb3.ncl.ac.uk/api/v1.1/sensors/PER_NE_CAJT_NCA189_SJB
6         1_SJB2" \
7             "/data/json/?starttime=20220901&endtime=20221001"
8
9     # Request data from Urban Observatory Platform
10    resp = requests.get(url)
11
12    # Convert response(Json) to dictionary format
13    raw_data_dict = resp.json()
14
15    print(raw_data_dict)
```

How to define MQTT subscriber in Python

MQTT subscriber

Python |

```
1 import json
2
3 from paho.mqtt import client as mqtt_client
4
5 if __name__ == '__main__':
6     mqtt_ip = "localhost"
7     mqtt_port = 1883
8     topic = "CSC8112"
9
10    # Create a mqtt client object
11    client = mqtt_client.Client()
12
13
14    # Callback function for MQTT connection
15    def on_connect(client, userdata, flags, rc):
16        if rc == 0:
17            print("Connected to MQTT OK!")
18        else:
19            print("Failed to connect, return code %d\n", rc)
20
21    # Connect to MQTT service
22    client.on_connect = on_connect
23    client.connect(mqtt_ip, mqtt_port)
24
25    # Callback function will be triggered
26    def on_message(client, userdata, msg):
27        print(f"Get message from publisher {json.loads(msg.payload)}")
28
29    # Subscribe MQTT topic
30    client.subscribe(topic)
31    client.on_message = on_message
32
33    # Start a thread to monitor message from publisher
34    client.loop_forever()
```

How to define MQTT publisher in Python

MQTT publisher

Python |

```
1 import json
2 from paho.mqtt import client as mqtt_client
3
4 if __name__ == '__main__':
5     mqtt_ip = "localhost"
6     mqtt_port = 1883
7     topic = "CSC8112"
8     msg = "Hello!"
9
10    # Create a mqtt client object
11    client = mqtt_client.Client()
12
13    # Callback function for MQTT connection
14    def on_connect(client, userdata, flags, rc):
15        if rc == 0:
16            print("Connected to MQTT OK!")
17        else:
18            print("Failed to connect, return code %d\n", rc)
19
20    # Connect to MQTT service
21    client.on_connect = on_connect
22    client.connect(mqtt_ip, mqtt_port)
23
24    # Publish message to MQTT
25    # Note: MQTT payload must be a string, bytearray, int, float or None
26    msg = json.dumps(msg)
27    client.publish(topic, msg)
```

How to define RabbitMQ consumer in Python

▼ RabbitMQ consumer

Python |

```
1 import json
2 import pika
3
4 if __name__ == '__main__':
5
6     rabbitmq_ip = "localhost"
7     rabbitmq_port = 5672
8     # Queue name
9     rabbitmq_queue = "CSC8112"
10
11 def callback(ch, method, properties, body):
12     print(f"Got message from producer msg: {json.loads(body)}")
13
14     # Connect to RabbitMQ service with timeout 1min
15     connection = pika.BlockingConnection(
16         pika.ConnectionParameters(host=rabbitmq_ip, port=rabbitmq_port, so-
cket_timeout=60))
17     channel = connection.channel()
18     # Declare a queue
19     channel.queue_declare(queue=rabbitmq_queue)
20
21     channel.basic_consume(queue=rabbitmq_queue,
22                           auto_ack=True,
23                           on_message_callback=callback)
24
25     channel.start_consuming()
```

How to define RabbitMQ producer in Python

```
1 import pika
2 import json
3
4 if __name__ == '__main__':
5     rabbitmq_ip = "localhost"
6     rabbitmq_port = 5672
7     # Queue name
8     rabbitmq_queue = "CSC8112"
9     msg = "Hello!"
10    # Connect to RabbitMQ service
11    connection = pika.BlockingConnection(pika.ConnectionParameters(host=rabbitmq_ip, port=rabbitmq_port))
12    channel = connection.channel()
13
14    # Declare a queue
15    channel.queue_declare(queue=rabbitmq_queue)
16
17    # Produce message
18    channel.basic_publish(exchange='',
19                          routing_key=rabbitmq_queue,
20                          body=json.dumps(msg))
21
22    connection.close()
```

How to use Matplotlib to visualize a line chart

```
1 import matplotlib.pyplot as plt
2 import pandas as pd
3
4 if __name__ == '__main__':
5     # Prepare data
6     data = {
7         'Timestamp': ['01/09', '02/09', '03/09', '04/09', '05/09'],
8         'Value': [1, 2, 1, 10, 5]
9     }
10
11     data_df = pd.DataFrame(data)
12
13     # Initialize a canvas
14     plt.figure(figsize=(8, 4), dpi=200)
15     # Plot data into canvas
16     plt.plot(data_df["Timestamp"], data_df["Value"], color="#FF3B1D", marker='.', linestyle="--")
17     plt.title("Example data for demonstration")
18     plt.xlabel("DateTime")
19     plt.ylabel("Value")
20
21     # Save as file
22     plt.savefig("figure1.png")
23     # Directly display
24     plt.show()
```

How to use Machine Learning Engine

▼ Using Machine Learning Engine

Python |

```
1  from ml_engine import MLPredictor
2
3  if __name__ == '__main__':
4      # Prepare data
5      data = {
6          'Timestamp': ['2020-09-01', '2020-09-02', '2020-09-03',
7                         '2020-09-04', '2020-09-05'],
8          'Value': [1, 2, 1, 10, 5]
9      }
10     data_df = pd.DataFrame(data)
11
12     # Create ML engine predictor object
13     predictor = MLPredictor(data_df)
14     # Train ML model
15     predictor.train()
16     # Do prediction
17     forecast = predictor.predict()
18
19     # Get canvas
20     fig = predictor.plot_result(forecast)
21     fig.savefig("prediction.png")
22     fig.show()
```

Problems

Docker logs cannot print output

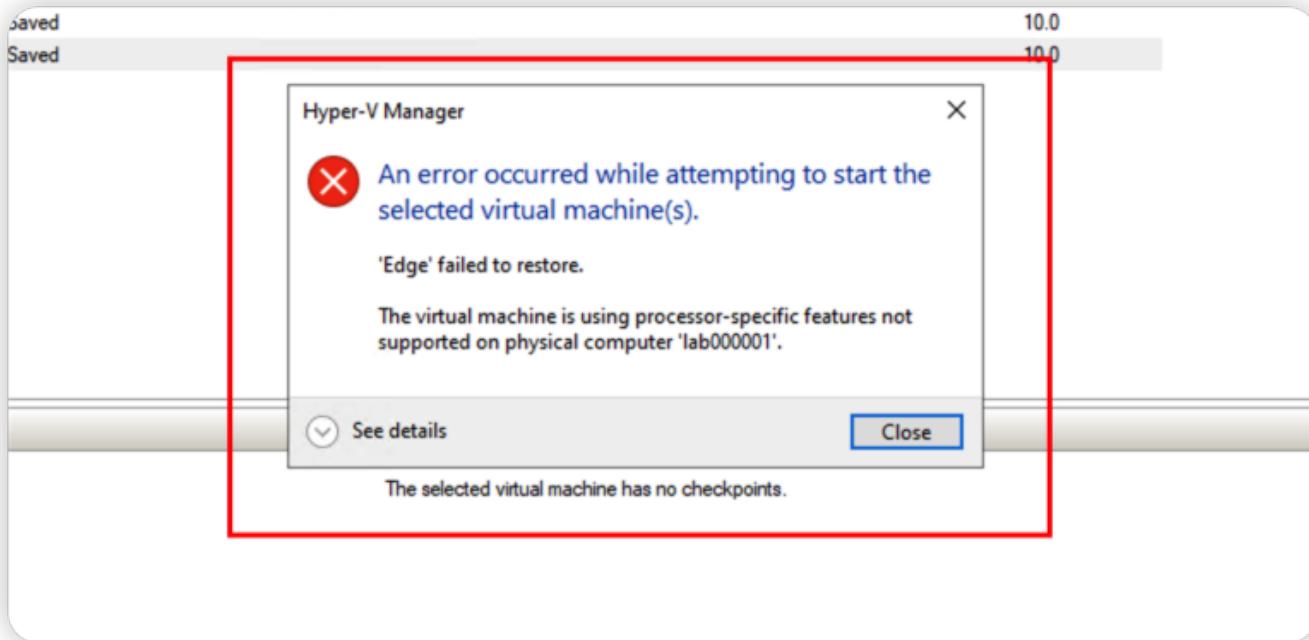
1. Please add (flush=True in your print code)

▼ print

Python |

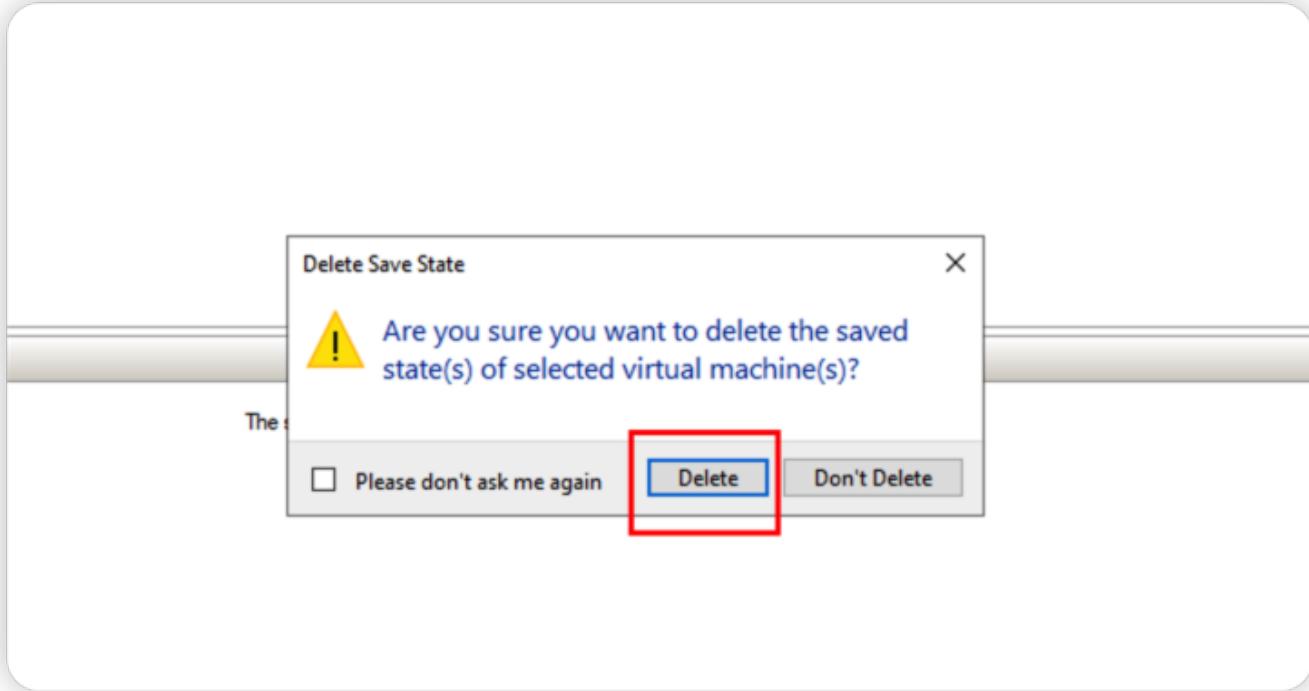
```
1  print("hello", flush=True)
```

An error occurred while attempting to start VM



Please delete the save status, and then try to start VM again. (Please make sure you have backup all important files before do this)

A screenshot of the Hyper-V Manager interface. The left pane shows a table of Virtual Machines with two entries: "Edge" and "Cloud", both in "Saved" state. The right pane shows the "Actions" menu for the selected virtual machine "LAB000001". A red box highlights the "Delete Saved State..." option under the "Cloud" section. Other options include "New", "Import Virtual Machine...", "Hyper-V Settings...", "Virtual Switch Manager...", "Virtual SAN Manager...", "Edit Disk...", "Inspect Disk...", "Stop Service", "Remove Server", "Refresh", "View", "Help", and "Cloud" options like "Connect...", "Settings...", "Start", "Checkpoint", "Move...", "Export...", "Rename...", and "Delete...".



Appendix

About target sensors information

Useful links:

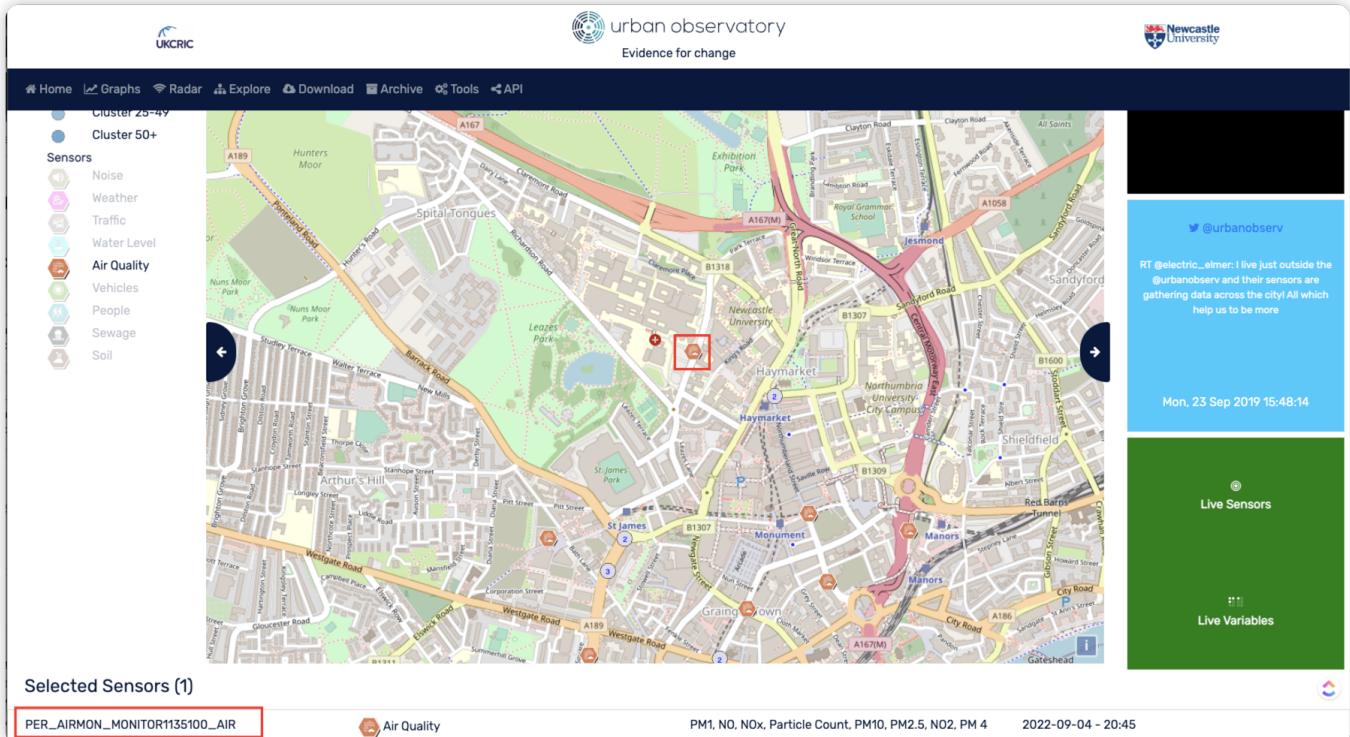
1. Urban Observatory : [Urban Observatory](#)
2. City Data API v1.1 doc : https://newcastle.urbanobservatory.ac.uk/api_docs/doc/sensors-csv/
3. Sensors search: https://newcastle.urbanobservatory.ac.uk/#sensor_info

Target sensor's information:

```
▼ Sensor Info JSON |  
1 {"Third Party": false, "Location (WKT)": "POINT(-1.617676 54.979118)", "Sensor Centroid Longitude": -1.617676,  
2 "Sensor Centroid Latitude": 54.979118, "Broker Name": "aq_mesh_api", "Sensor Height Above Ground": 2.0,  
3 "Raw ID": "79525", "Ground Height Above Sea Level": 57.6699981689, "Sensor Name": "PER_AIRMON_MONITOR1135100"}
```

About Raw Data:

- **Date range:** From 01/06/2023 to 31/08/2023.
- **Data format:** JSON
- **Size:** around 17MB(total)
 - PM2.5 data (total data points: 8711 with timestamp in millisecond, collecting rate: every 15min (900000ms))



Geo-location of target sensor

For Demonstrators

此处为语雀加密文本卡片，点击链接查看：

https://www.yuque.com/_workers/ruisun/uni_task/vqgl8p/pdf#zjG1R