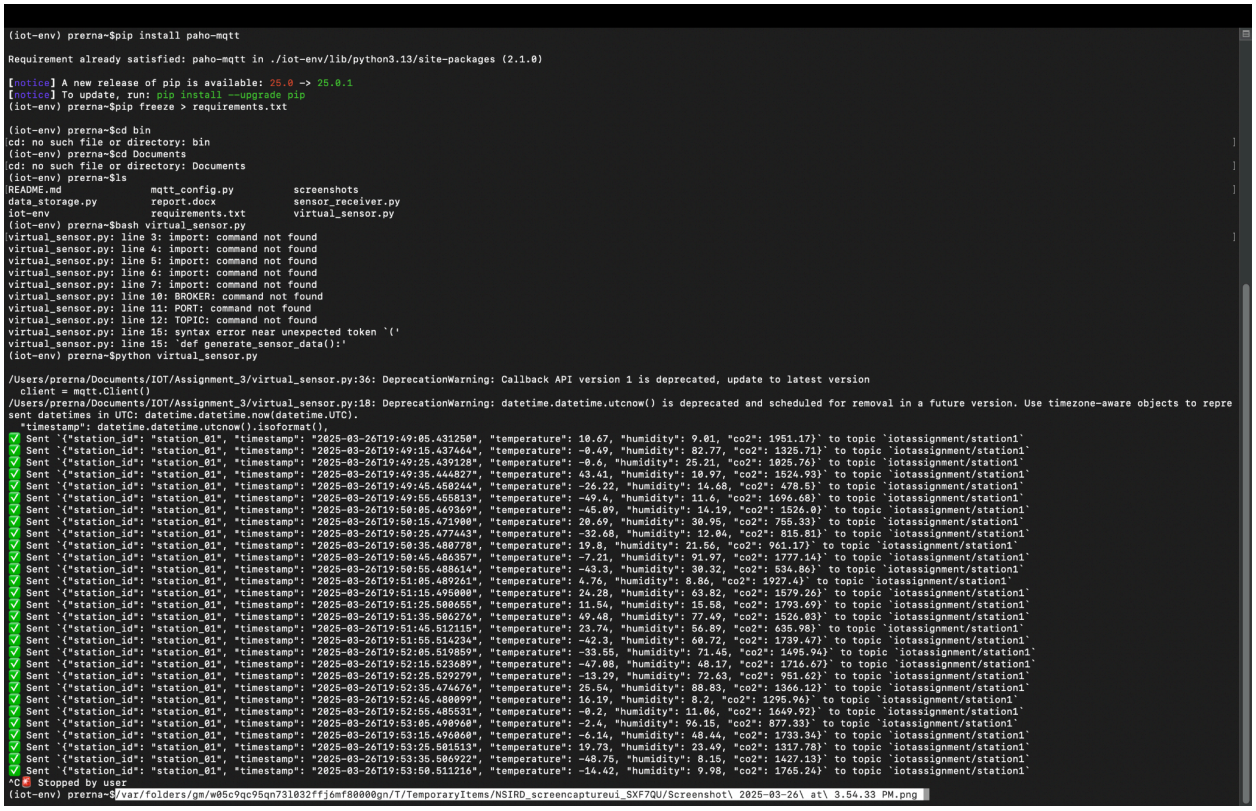
Report for IoT Assignment 3

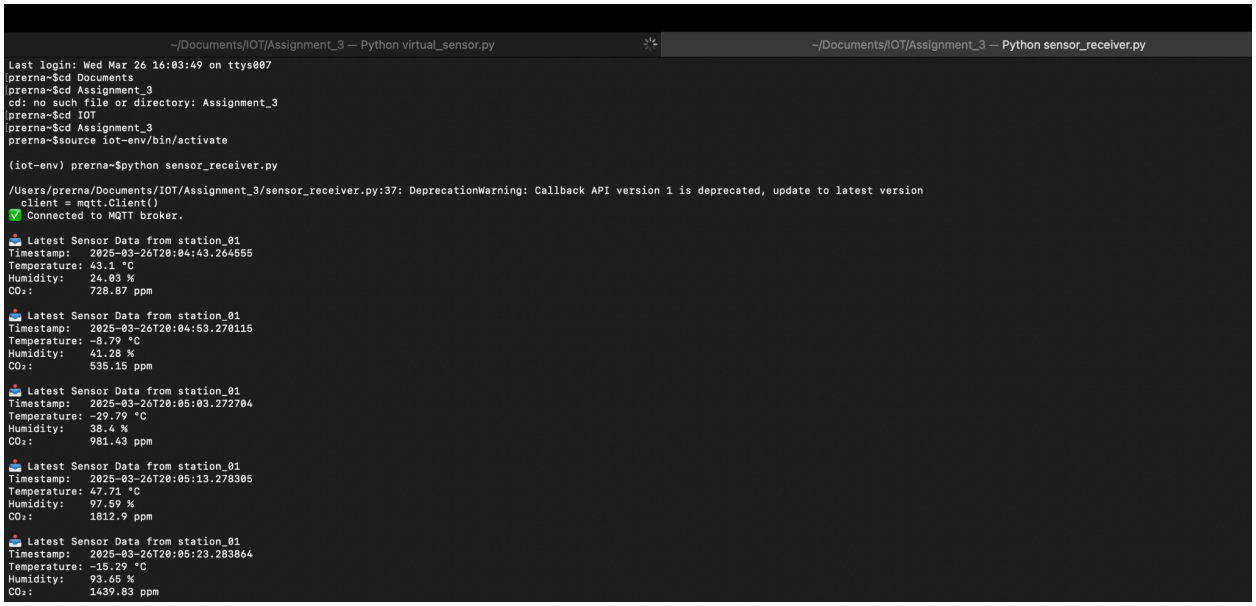
1) **Brief explanation of the steps that you have used in developing the IOT system:**

- To begin the project, I set up a Python virtual environment to keep the workspace clean and isolated. Inside this environment, I installed the required library, paho-mqtt, which supports MQTT communication , the main protocol used for this assignment.
- The first script I created was virtual_sensor.py. This script simulates a virtual environmental station. It randomly generates data for three sensors: temperature (between -50°C and 50°C), humidity (0% to 100%), and CO2 (300 to 2000 ppm). Each sensor reading is grouped into a message that also includes the station ID and a timestamp. These messages are then published every 10 seconds to a topic on the public MQTT broker test.mosquitto.org. This helped replicate the behavior of real-world IoT devices sending data at regular intervals.
- After successfully publishing sensor data, I developed sensor_receiver.py. This script acts as a subscriber. It connects to the same MQTT topic and listens for incoming messages. When it receives a message, it checks if it's from the correct station and then displays the most recent temperature, humidity, and CO2 values along with the timestamp. This real-time data reception confirmed that the system was correctly transmitting and receiving environmental data.
- To complete the assignment requirements, I then created data_storage.py. This script listens for sensor data like the receiver, but it also stores every incoming reading into a local JSON file. Additionally, it includes functionality to retrieve and display all the readings for a specific sensor (temperature, humidity, or CO2) received in the last five hours. This required working with timestamps and filtering the stored data to match the time window.
- Throughout the project, I regularly tested each script to make sure data was flowing as expected. I ran the virtual sensor and receiver together, verified that the messages were received properly, and confirmed that the historical data feature worked by checking the stored file and filtered output. I also took screenshots to document each of these steps for the final report.
- Overall, this project helped me understand how different parts of an IoT system work together including data generation, message publishing, real-time processing, and storage using Python and MQTT. It was a hands-on way to experience how virtual sensors and cloud communication come together in real-world IoT applications.

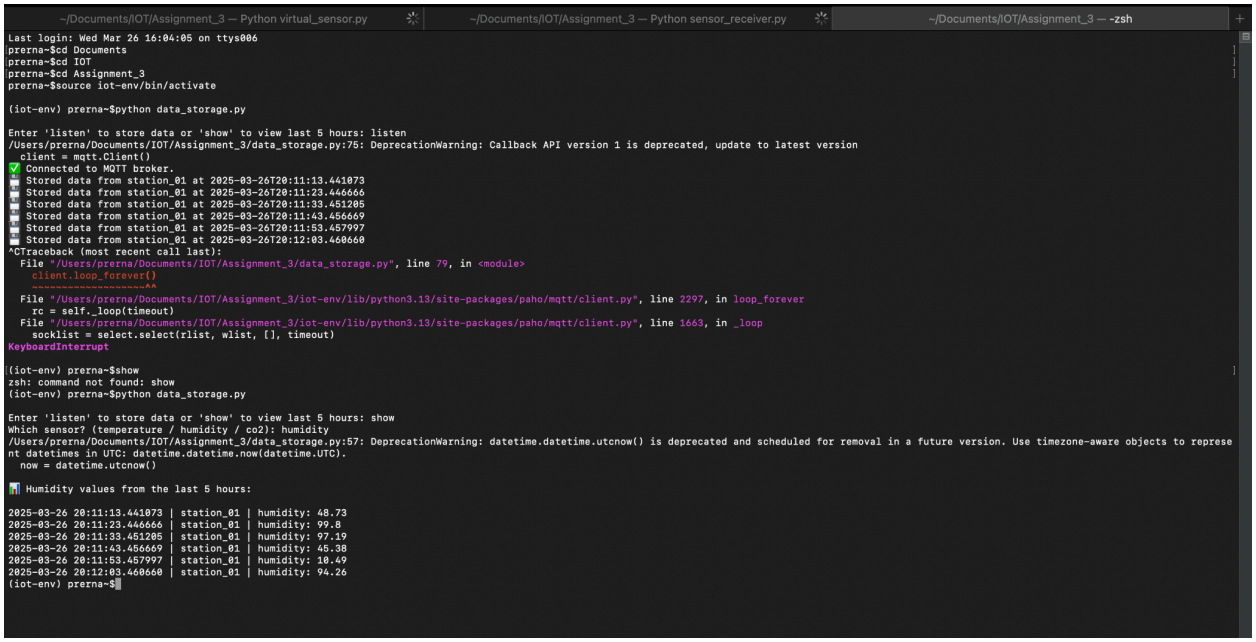
2) Screenshots of your output



```
(iot-env) prerna~$pip install paho-mqtt

Requirement already satisfied: paho-mqtt in ./iot-env/lib/python3.13/site-packages (2.1.0)

[notice] A new release of pip is available: 25.0 -> 25.0.1
[notice] To update, run: pip install --upgrade pip
(iot-env) prerna~$pip freeze > requirements.txt

(iot-env) prerna~$cd bin
cd: no such file or directory: bin
(iot-env) prerna~$cd Documents
cd: no such file or directory: Documents
(iot-env) prerna~$ls
README.md               mqtt_config.py          screenshots
data_storage.py         report.docx             sensor_receiver.py
iot-env                 requirements.txt        virtual_sensor.py
(iot-env) prerna~$bash virtual_sensor.py
virtual_sensor.py: line 3: import: command not found
virtual_sensor.py: line 4: import: command not found
virtual_sensor.py: line 5: import: command not found
virtual_sensor.py: line 6: import: command not found
virtual_sensor.py: line 7: import: command not found
virtual_sensor.py: line 10: BROKER: command not found
virtual_sensor.py: line 11: PORT: command not found
virtual_sensor.py: line 12: TOPIC: command not found
virtual_sensor.py: line 15: syntax error near unexpected token `('
virtual_sensor.py: line 15: `def generate_sensor_data():'
(iot-env) prerna~$python virtual_sensor.py

/Users/prerna/Documents/IOT/Assignment_3/virtual_sensor.py:36: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
  client = mqtt.Client()
/Users/prerna/Documents/IOT/Assignment_3/virtual_sensor.py:18: DeprecationWarning: datetime.datetime.utcnow() is deprecated and scheduled for removal in a future version. Use timezone-aware objects to repre
sent datetimes in UTC: datetime.datetime.now(datetime.UTC).
  "timestamp": datetime.datetime.utcnow().isoformat(),
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:05.431250", "temperature": 10.67, "humidity": 9.01, "co2": 1951.17}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:15.437464", "temperature": -0.49, "humidity": 82.77, "co2": 1325.71}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:25.439128", "temperature": -0.6, "humidity": 25.21, "co2": 1025.76}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:35.444827", "temperature": 43.41, "humidity": 10.97, "co2": 1524.93}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:45.450244", "temperature": -26.22, "humidity": 14.68, "co2": 478.5}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:49:55.455813", "temperature": -49.4, "humidity": 11.6, "co2": 1696.68}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:05.469369", "temperature": -45.09, "humidity": 14.19, "co2": 1526.0}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:15.471908", "temperature": 20.69, "humidity": 30.95, "co2": 755.33}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:25.477443", "temperature": -32.68, "humidity": 12.04, "co2": 815.81}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:35.480778", "temperature": 19.8, "humidity": 21.56, "co2": 961.17}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:45.486357", "temperature": -7.21, "humidity": 91.97, "co2": 1777.14}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:50:55.488614", "temperature": -43.3, "humidity": 30.32, "co2": 534.86}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:05.489261", "temperature": 4.76, "humidity": 8.86, "co2": 1927.4}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:15.495000", "temperature": 24.28, "humidity": 63.82, "co2": 1579.26}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:25.500655", "temperature": 11.54, "humidity": 15.58, "co2": 1793.69}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:35.506276", "temperature": 49.48, "humidity": 77.49, "co2": 1526.03}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:45.512115", "temperature": 23.74, "humidity": 56.89, "co2": 635.98}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:51:55.514234", "temperature": -42.3, "humidity": 60.72, "co2": 1739.47}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:05.519859", "temperature": -33.55, "humidity": 71.45, "co2": 1495.94}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:15.523689", "temperature": -47.08, "humidity": 48.17, "co2": 1716.67}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:25.529279", "temperature": -13.29, "humidity": 72.63, "co2": 951.62}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:35.474676", "temperature": 25.54, "humidity": 88.83, "co2": 1366.12}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:45.480099", "temperature": 16.19, "humidity": 8.2, "co2": 1295.96}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:52:55.485531", "temperature": -0.2, "humidity": 11.06, "co2": 1649.92}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:53:05.490960", "temperature": -2.4, "humidity": 96.15, "co2": 877.33}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:53:15.496060", "temperature": -6.14, "humidity": 48.44, "co2": 1733.34}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:53:25.501513", "temperature": 19.73, "humidity": 23.49, "co2": 1317.78}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:53:35.506922", "temperature": -48.75, "humidity": 8.15, "co2": 1427.13}` to topic `iotassignment/station1`
✅ Sent `{"station_id": "station_01", "timestamp": "2025-03-26T19:53:50.511216", "temperature": -14.42, "humidity": 9.98, "co2": 1765.24}` to topic `iotassignment/station1`
^C🛑 Stopped by user
(iot-env) prerna~$/var/folders/gm/w05c9qc95qn731032ffj6mf80000gn/T/TemporaryItems/NSIRD_screencaptureui_SXF7QU/Screenshot\ 2025-03-26\ at\ 3.54.33 PM.png
```



```
~/Documents/IOT/Assignment_3 — Python virtual_sensor.py    ~/Documents/IOT/Assignment_3 — Python sensor_receiver.py

Last login: Wed Mar 26 16:03:49 on ttys007
prerna~$cd Documents
prerna~$cd Assignment_3
cd: no such file or directory: Assignment_3
prerna~$cd IOT
prerna~$cd Assignment_3
prerna~$source iot-env/bin/activate

(iot-env) prerna~$python sensor_receiver.py

/Users/prerna/Documents/IOT/Assignment_3/sensor_receiver.py:37: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
  client = mqtt.Client()
✅ Connected to MQTT broker.

📥 Latest Sensor Data from station_01
Timestamp:   2025-03-26T20:04:43.264555
Temperature: 43.1 °C
Humidity:    24.03 %
CO₂:         728.87 ppm

📥 Latest Sensor Data from station_01
Timestamp:   2025-03-26T20:04:53.270115
Temperature: -8.79 °C
Humidity:    41.28 %
CO₂:         535.15 ppm

📥 Latest Sensor Data from station_01
Timestamp:   2025-03-26T20:05:03.272704
Temperature: -29.79 °C
Humidity:    38.4 %
CO₂:         981.43 ppm

📥 Latest Sensor Data from station_01
Timestamp:   2025-03-26T20:05:13.278305
Temperature: 47.71 °C
Humidity:    97.59 %
CO₂:         1812.9 ppm

📥 Latest Sensor Data from station_01
Timestamp:   2025-03-26T20:05:23.283864
Temperature: -15.29 °C
Humidity:    93.65 %
CO₂:         1439.83 ppm
```



3) **Include the URL of a GitHub repository where you will push all your code and scripts that are Needed To realize the assignment, along with a main README.md file**

   https://github.com/prerna1001/IOT_Assignment_3/tree/main

4) **Write a reflection on a specific experience that you have had when completing this assignment (Incorporate your personal thoughts and opinions).**

- This assignment gave me a hands-on understanding of how IoT systems work from end to end , generating data, sending it to the cloud, and processing it in real time. The MQTT part was new to me, so learning how the publisher and subscriber talk to each other was really interesting.
- One of the more frustrating but valuable experiences was getting GitHub authentication to work. I ran into multiple permission and SSH key issues, but solving those taught me a lot about how Git and GitHub manage access. Once everything was connected, seeing the virtual sensor push live data and the subscriber respond instantly was super satisfying.
- Overall, this assignment helped me connect technical concepts to real-world workflows, and gave me a better understanding of how sensor-based systems communicate and store data.