KENNESAW STATE UNIVERSITY

CPE 4040: Data Collection and Analysis, Spring 2024

Laboratory Report #4

Raspberry Pi Weather Station Application on ThingSpeak

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I. Objective

1. Learn how to interface and read data from a temperature sensor.
2. Learn how to communicate with the popular ThingSpeak cloud platform.
3. Understand how to make HTTP client-server connection with Raspberry Pi.
4. Understand how to create a cloud server application with Raspberry Pi.
5. Learn how to control output of Raspberry Pi remotely from the cloud service

II. Material List

Hardware:

- Temperature Sensor (we have the DHT-11)
- Breadboard, LED, and resistor (we used a 10k resistor)
- Power Cord

Software:

- Remote Desktop Connection
- ThingSpeak cloud Platform

III. Lab Procedures and Results

1. We plug the power adapter to the Raspberry Pi and power up the system. We open Remote Desktop Connection (or SSH connection) on our laptop and connect to Raspberry Pi.

Section 1: Connect and Test the Temperature Sensor

2. We open a terminal window and type `pip3 list` to see which Python packages are installed in our device.
3. We make sure the following packages are installed already: ***urllib3, python-http-client, requests***. **Question**: What are those three packages intended for? Do Google searches and give a brief description for each package. The three packages – urllib3, python-http-client,

and requests – are essential for creating an HTTP client-server connection with the Raspberry Pi.

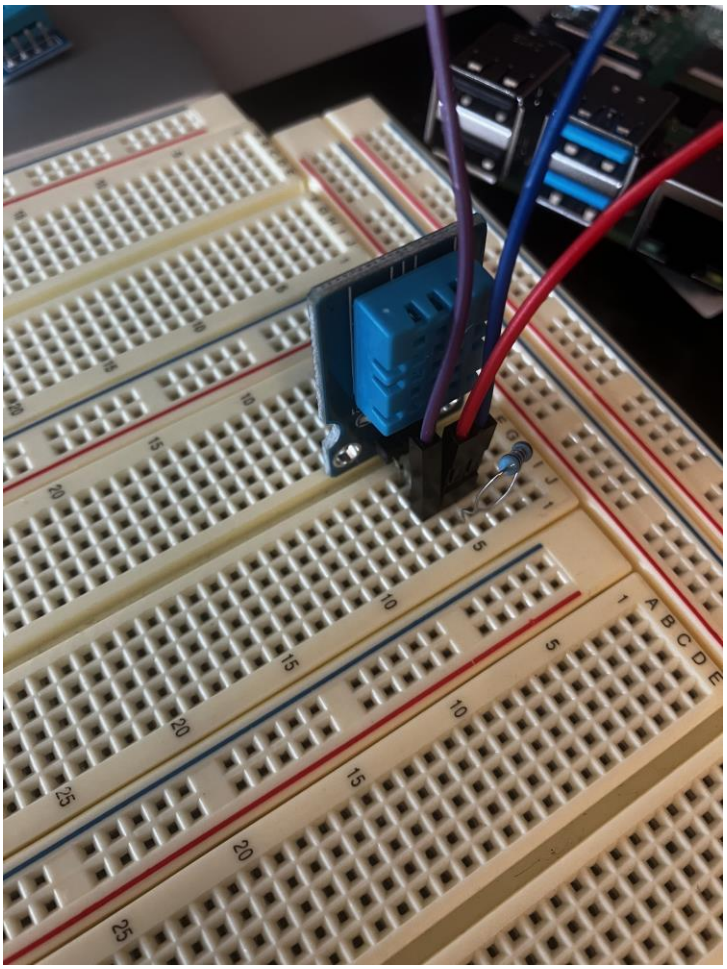
urllib3: A powerful HTTP client for Python with features such as connection pooling, thread safety, and support for various authentication schemes.

python-http-client: A simple HTTP client library for Python that facilitates making HTTP requests.

requests: A widely-used Python library for sending HTTP requests and handling responses. rewrite this a bit simpler.

Type `pip3 install <package name>` to install the packages. (if they aren't already installed)

4. We connect the temperature sensor to Raspberry Pi with the below connection diagram. The resistor we use is 10kΩ placed between Vcc and DATA pins of the sensor. This is a picture of our hardware setup.

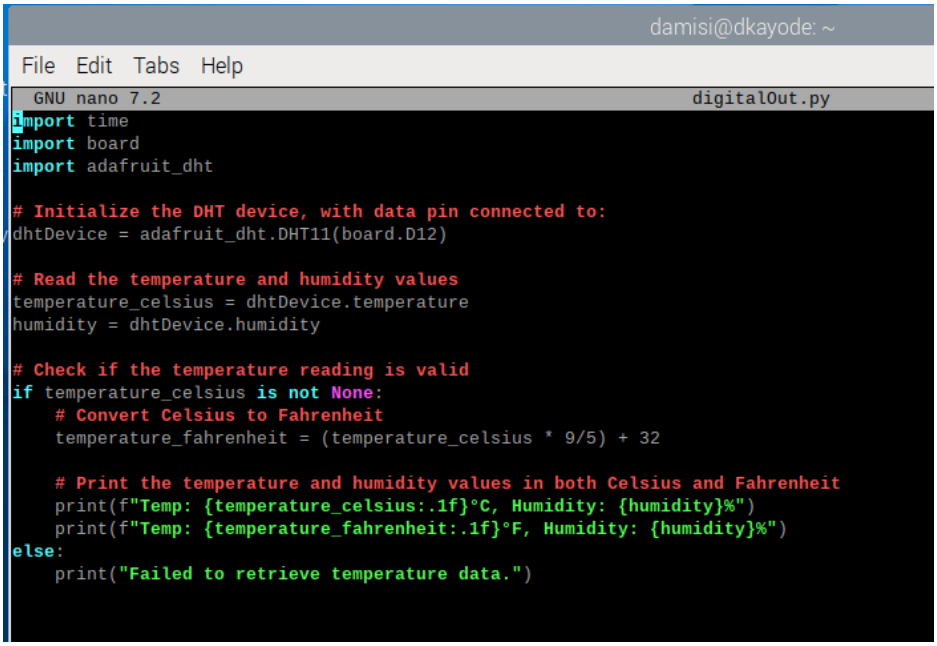


5. We install the DHT library which contains the device driver for DHT-11 or DHT-22 :

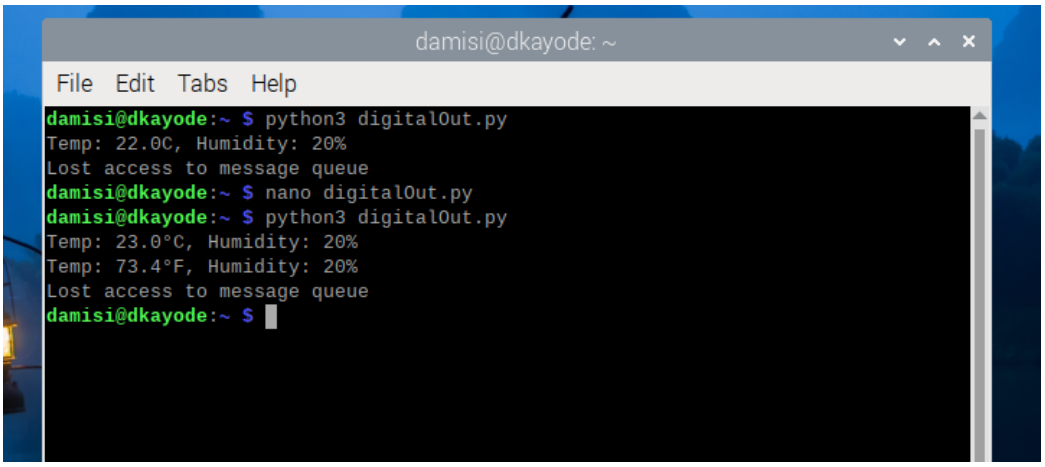
```
pip3 install adafruit-circuitpython-dht

sudo apt-get install libgpiod2
```

Question: What is the library libgpiod2 for? libgpiod2: This library provides C library and tools for interacting with the GPIO character device.

6. We create a file (*digitalOut.py*) with the python code below to get sensor readings from our DHT-11.



7. We check whether the temperature and humidity readings are reasonable.



We add a small piece of code to convert temperature values from C (Celsius) to F (Fahrenheit).

damisi@dkayode: ~

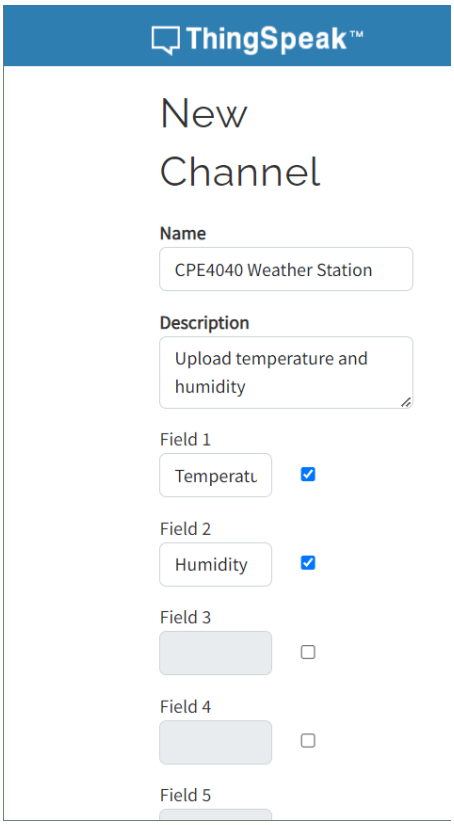
File Edit Tabs Help

GNU nano 7.2 digitalOut.py

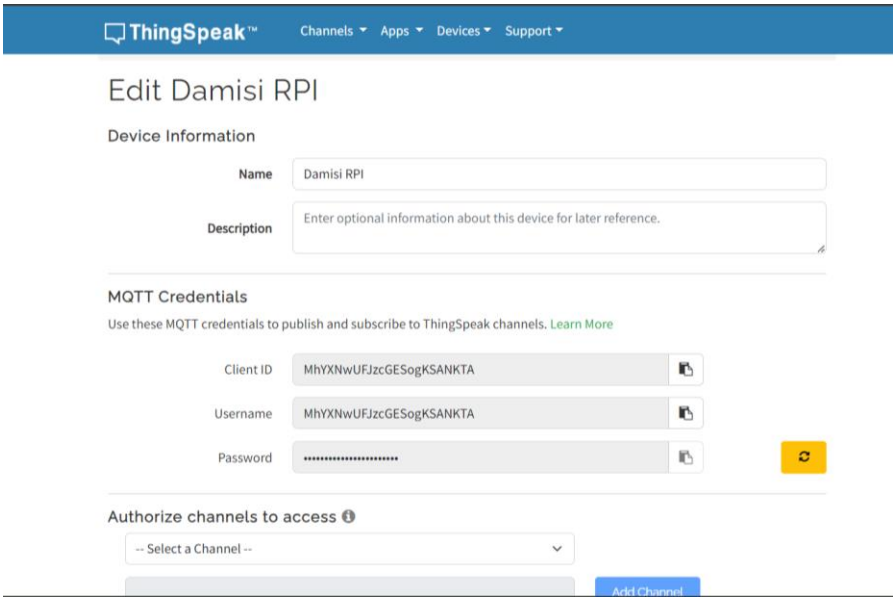
```
import time
import board
import adafruit_dht

# Initialize the DHT device, with data pin connected to:
dhtDevice = adafruit_dht.DHT11(board.D12)

# Read the temperature and humidity values
temperature_celsius = dhtDevice.temperature
humidity = dhtDevice.humidity

# Check if the temperature reading is valid
if temperature_celsius is not None:
    # Convert Celsius to Fahrenheit
    temperature_fahrenheit = (temperature_celsius * 9/5) + 32

    # Print the temperature and humidity values in both Celsius and Fahrenheit
    print(f"Temp: {temperature_celsius:.1f}°C, Humidity: {humidity}%")
    print(f"Temp: {temperature_fahrenheit:.1f}°F, Humidity: {humidity}%")
else:
    print("Failed to retrieve temperature data.")
```

Section 2: Create a ThingSpeak Channel for the MQTT Device

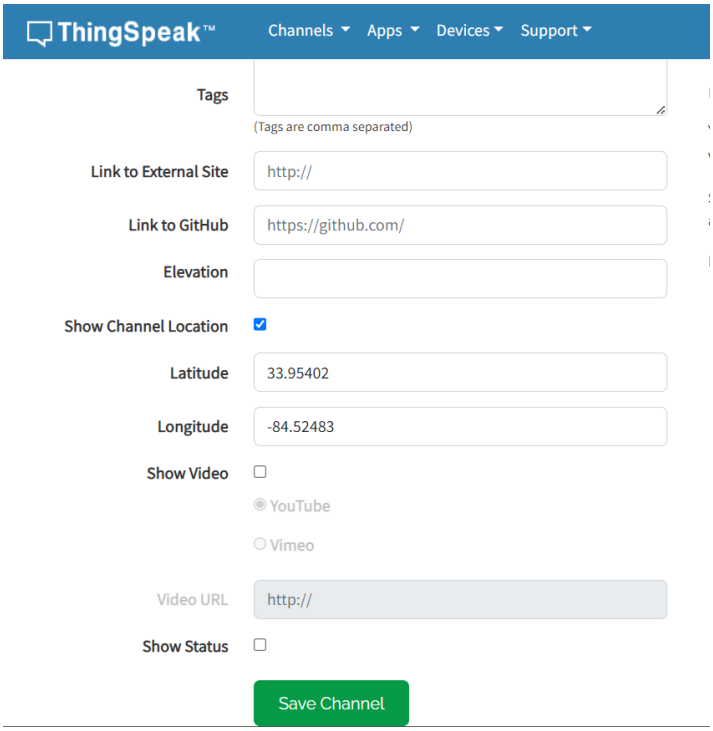
8. We sign up for a free ThingSpeak account using your KSU email.
9. In order to upload data to the ThinkSpeak Cloud, we create a ***Channel*** first. We set it up as shown in the figure below.



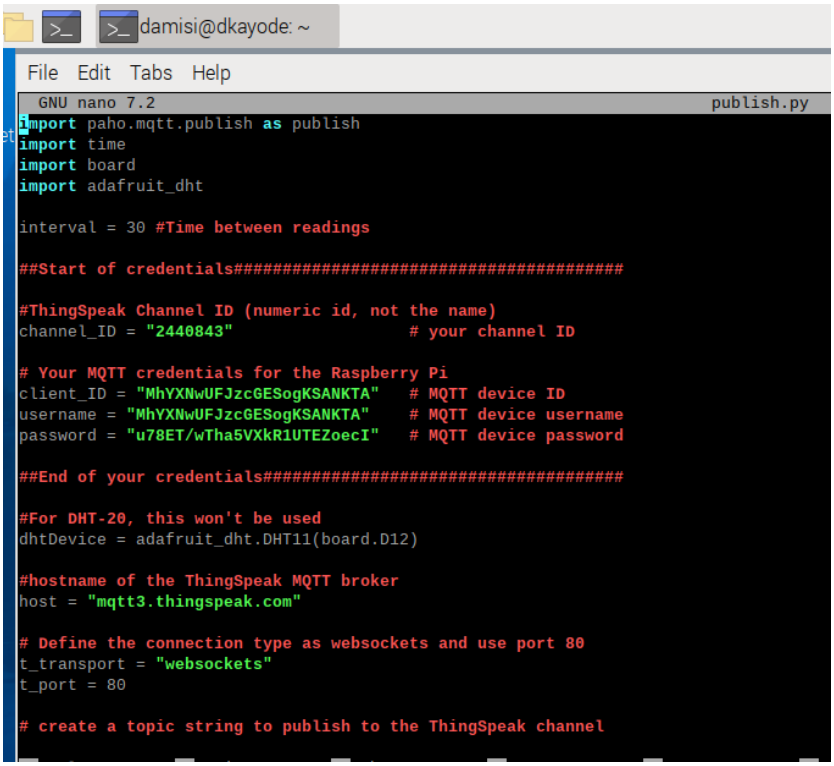
10. In the "Devices" in the menu bar we create an MQTT device (our Raspberry Pi). We provide the device a name, add the channel that we just created, then click "Add Channel". The MQTT credentials of this device will show up (Client ID, Username and Password). We save them in a separate text file as we will use them in Step 13.

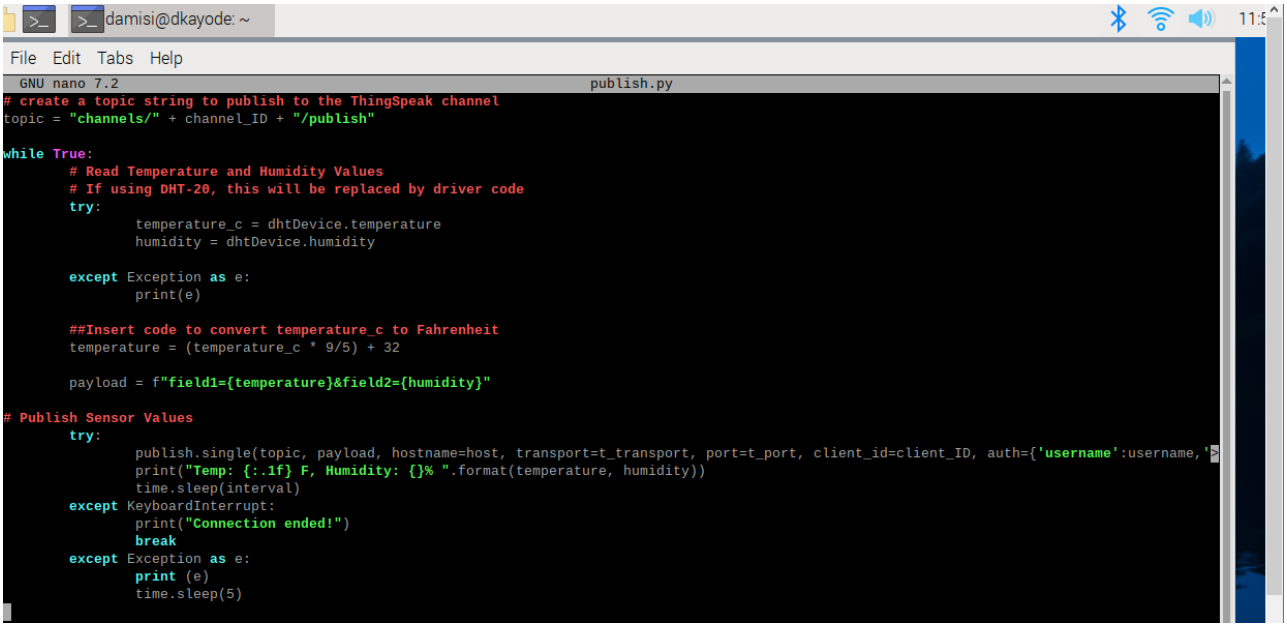


11. In "Channel Settings", scroll down and check the box "Show Channel Location". We find the coordinate points of our location from Google Maps and paste it into the corresponding boxes that are now available under Channel Settings. When done, we save the channel, and are redirected to the main page of the newly created channel. We write down "Channel ID", which will be used shortly.



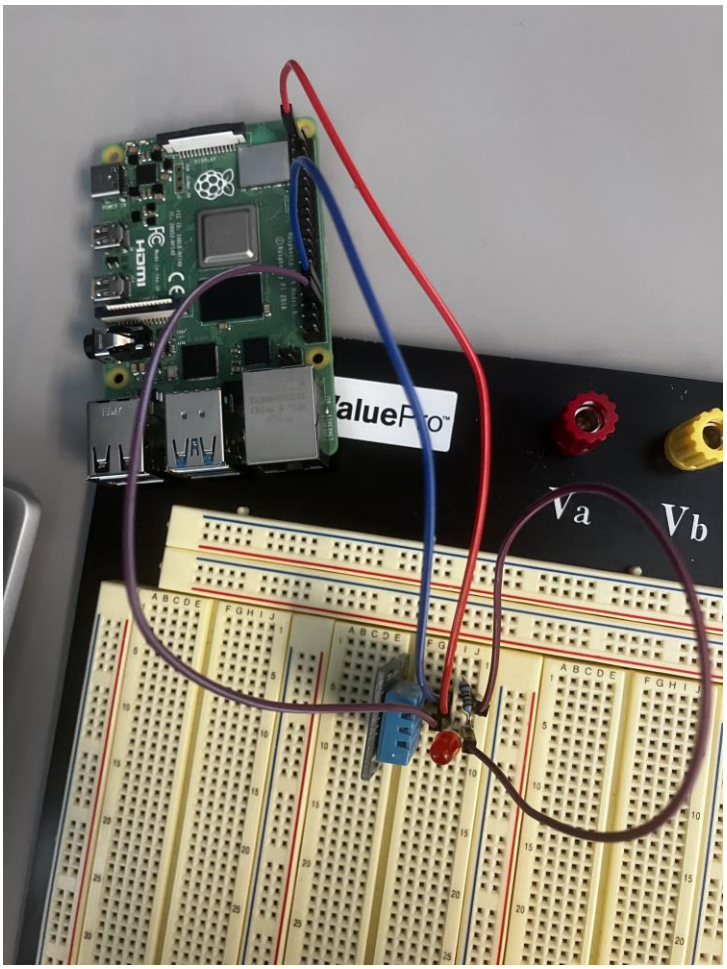
12. In "API Keys" in the manual bar and we write down the key in the "Write API Key" section.
13. We open the reference Python program, ***publish.py***, and modify the code as instructed. When running the code, w see sensor data posting to our ThingSpeak channel in real time.





Note: For channel ID, username and password, you will use the ones obtained in Step 10. In the *while* loop, include the modification that you did in Step 7 to convert the temperature unit to Fahrenheit.

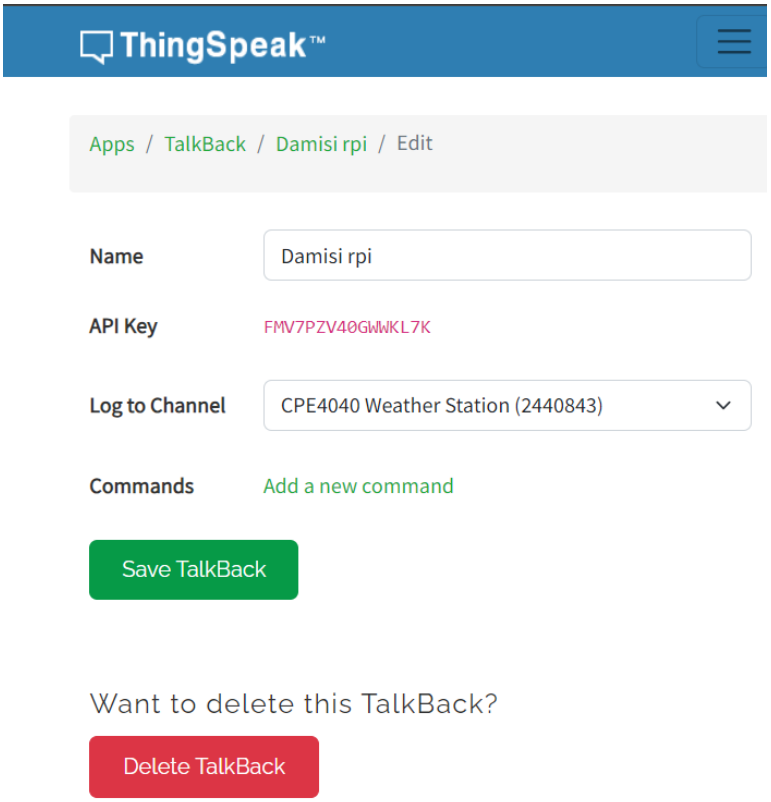
14. Connect an LED to GPIO12 of Raspberry Pi with a serial resistor (the same thing you did in Lab 3).



Section 3: Sending Alert from Your Weather Station

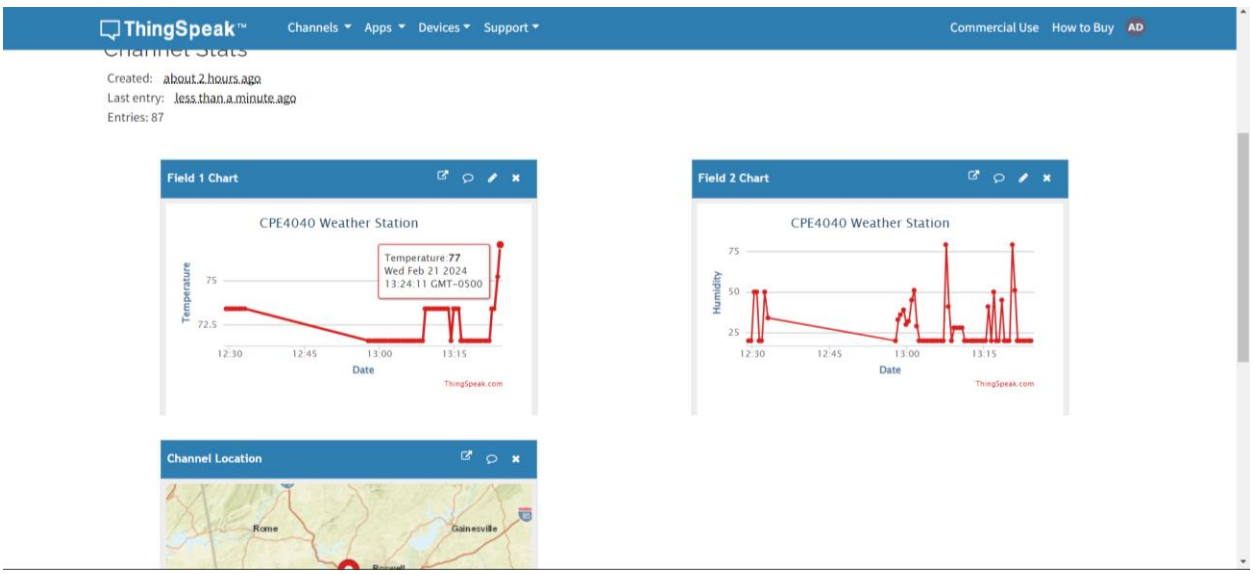
When the temperature exceeds 75°F, an alert will be sent to Raspberry Pi and the LED will be turned on. This will be achieved using three ThingSpeak applications, as shown in the flowchart below.

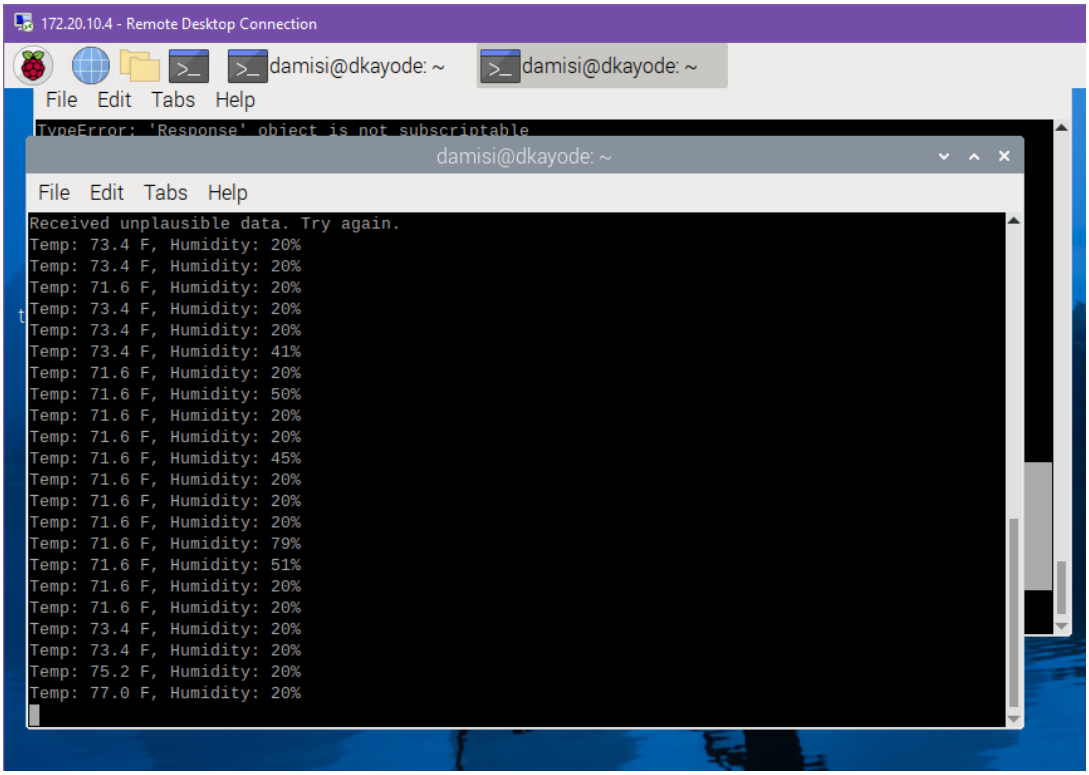
15. To generate an action when the temperature exceeds 75°F, we will use the **TalkBack** app. Go to Apps on the ThingSpeak home page and select TalkBack. Select the "New TalkBack" button, then enter a name to select our channel in the "Log to Channel" option. Save and exit.



TalkBack is where Raspberry Pi periodically accesses and polls commands. To generate commands for the result of events, we use the **React** app in ThingSpeak.

16. We will create two new Reacts: one for the temperature exceeding above 75°F and one for the temperature dropping below 75°F. Both are similarly defined as in the figure below.

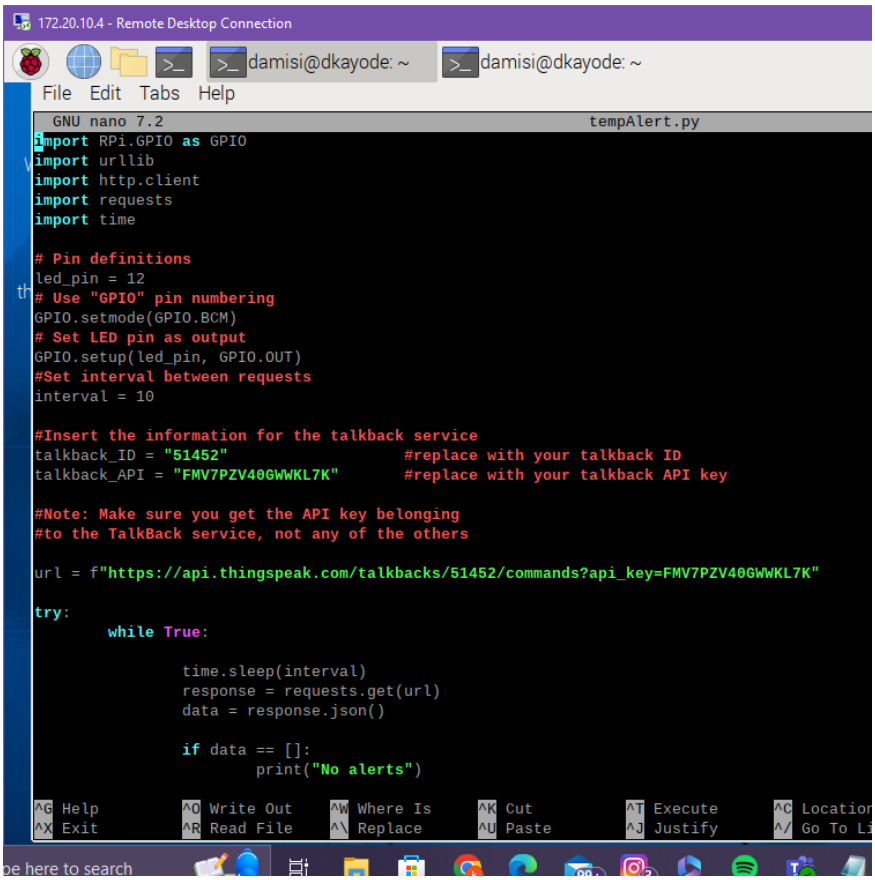


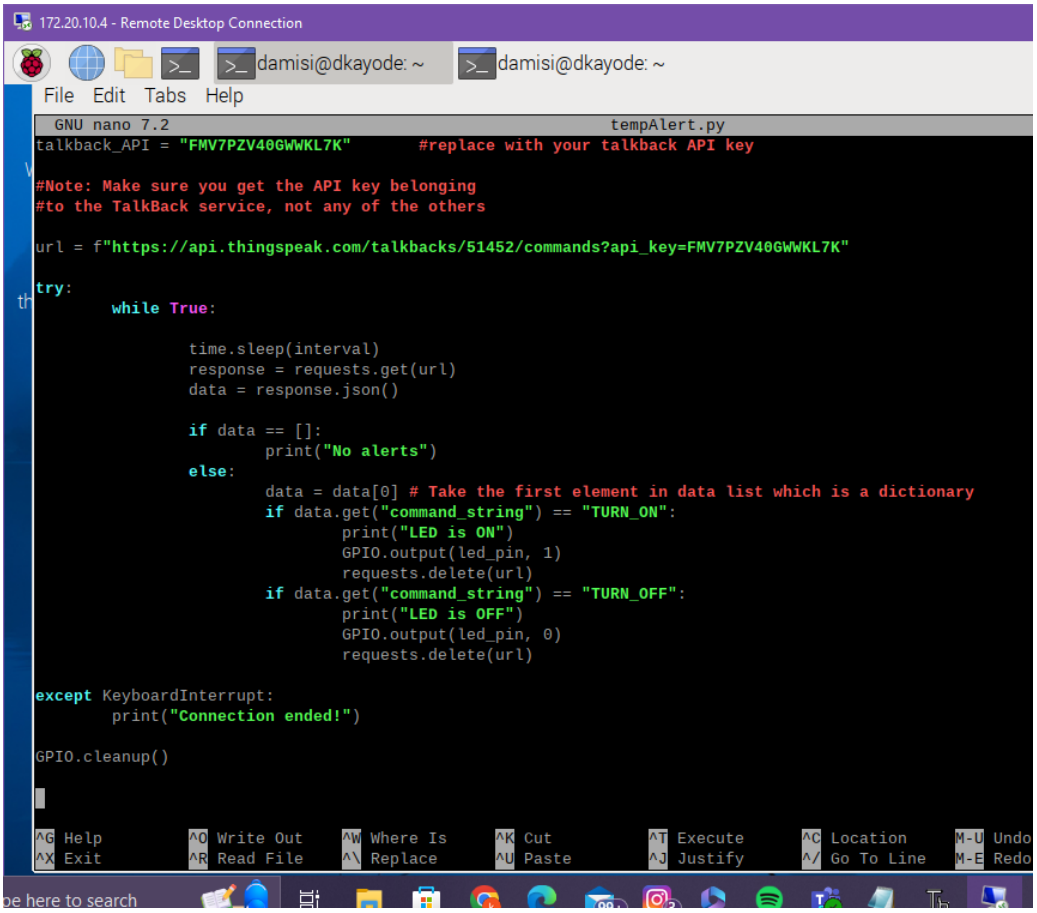


17. When the condition is met in **React**, a trigger will be sent to **ThingHTTP** to generate a POST command to **TalkBack**. We set up two separate ThingHTTP requests. For each request, fill in the configuration settings as illustrated in the figure below.
18. After setting up ThingSpeak, we open the reference Python program, *tempAlert.py*, and modify the code as instructed. It will make HTTP connection to poll commands from the TalkBack app to turn on or off the LED.

When executing the code, the LED should be turned on when the temperature goes above 75°F and turned off when it drops below 75°F. You can place your finger on the sensor or use a hair dryer to accelerate the heat-up!

You should run this code on another terminal while ***publish.py*** is still running.





IV. Conclusion

This lab taught us how to create a Raspberry Pi Weather Station and use ThingSpeak for analyzing data. We got to do practical stuff like connecting a temperature sensor, making a cloud server, and using it to detect the temperature and humidity of the environment

We faced a problem while installing some Python packages using pip3. The regular method didn't work smoothly, so we used the 'break' command to force the installation. This was probably due to differences in the raspberry pi versions. To help others, it would be good to include troubleshooting steps in the lab guide, especially for common installation problems.