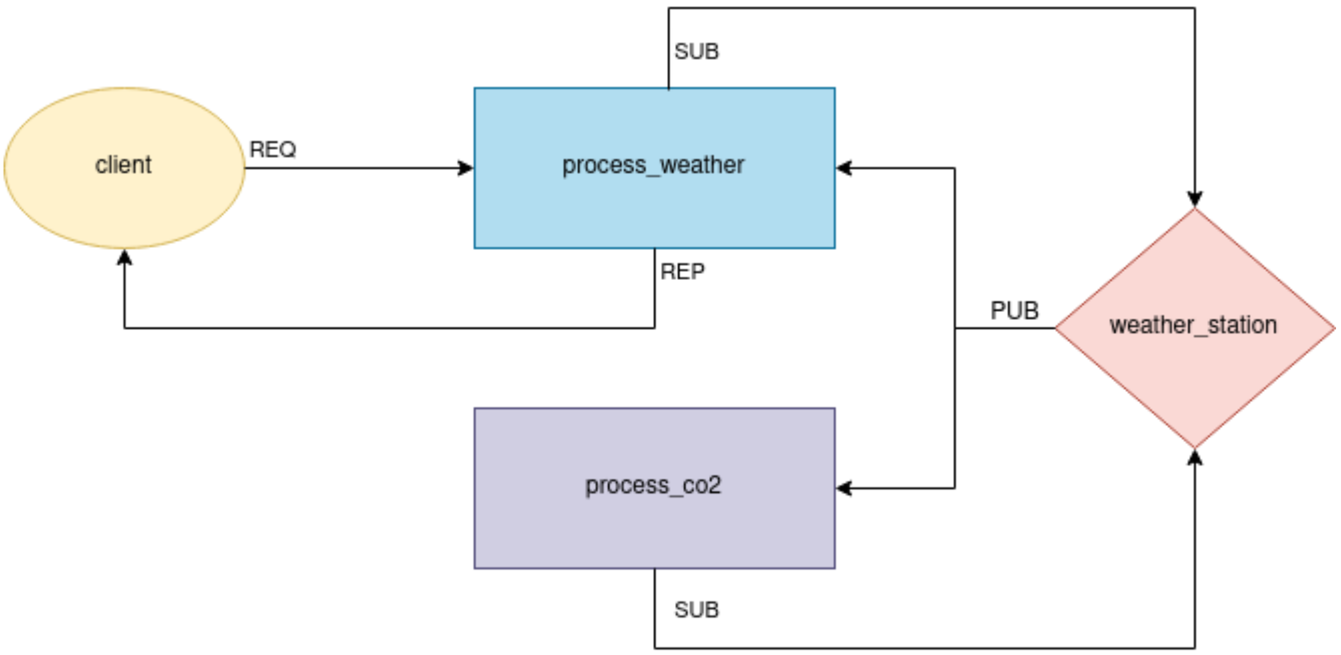
Week 3 - ZeroMQ

> Distributed and Networking Programming - Spring 2024

Overview

Your task for this lab is to organize a (simple) real-time distributed Weather Data Management system using the ZeroMQ (https://zguide.zeromq.org/docs/chapter1/).

System Architecture



- **Weather Station (`weather_station.py`)**:
    - Generates random humidity and temperature levels every 2 seconds, with temperature ranging from 5 to 40°C and humidity ranging from 40 to 100%.
    - Formats the weather data as a JSON string, including a timestamp.
    - Generates random CO2 level rangin from 300 to 500 parts per million, ppm.
    - Formats the CO2 data as a JSON string, including a timestamp.
    - Sends the generated data to the "weather and CO2 processing" servers via ZeroMQ, using a PUB socket bound to a specified address.
    - Continuously operates unless interrupted by a keyboard interrupt.
    - Example message for Weather data: `weather {"time": "2024-03-31 17:51:39", "temperature": 28.8, "humidity": 75.2}`

  - Example message for CO2 data: `co2 {"time": "2024-04-02 02:44:28", "co2": 354.3}`
  - You can wait for 2 seconds between sending these messages.
  - If you faced an issue that the first data is not received on the server, please use 2 sec sleep in the begining of your while loop.

- **Weather Processing Server (`process_weather.py`)**:
  - Subscribes to data from weather stations via ZeroMQ and only receives data with option= "weather". For example you can use like `setsockopt_string(zmq.SUBSCRIBE, "weather")`
  - Logs the received data in `weather_data.log` .
  - Computes the average temperature and humidity of the `last 30 seconds` to use later.
  - Reply to client based on the average data that you compute when he requests for either weather information or suitable clothing recommendations.
  - If a client requests "Fashion", provides a recommendation based on the last saved average temperature:
    - If the average is less than `10°C` , suggests wearing warm clothes.
    - If the average is between 10°C and `25°C` , suggests spring/autumn clothes.
    - If the average is above `25°C` , recommends wearing light clothes.
  - If a client requests "Weather", sends the last saved temperature and humidity values.
  - If the request is neither of those, reply with `Query Not Found`
  - Implement this server using threads:
    - Since client may send requests in different times, and data from data proccessing server is coming nonstop, we need to implement this part with threads.
    - Create 2 threads 1 for accepting client queries and and for receiving weather datas to handle this situation.

- **CO2 Processing Server (`process_co2.py`)**:
  - Subscribes to data from weather stations via ZeroMQ and only receives data with option= "co2".
  - Logs the received data in `co2_data.log` .
  - Check if the amount of CO2 is higher than 400, `print("Danger Zone! Please do not leave home")`

- **Client (`client.py`)**:
  - Requests weather information and suitable clothing recommendations from the reporter.
  - Continuously operates unless interrupted by a keyboard interrupt.
  - Prompts the user to enter a query (either "Fashion" or "Weather").
  - Sends the entered query to the appropriate service (Fashion or Weather).
  - Receives and displays the response from the service.
  - Alerts the user if the entered query is invalid and prompts for a valid input.

Task

Implement the system components as described above using `pyzmq` package (https://pypi.org/project/pyzmq/) (import as `zmq`).

Example Run

```
$ python weather_station.py
Weather is sent from WS1 {"time": "2024-04-02 03:24:40", "temperature": 23.3,
CO2 is sent from WS1 {"time": "2024-04-02 03:24:42", "co2": 461.7}
Weather is sent from WS1 {"time": "2024-04-02 03:24:44", "temperature": 35.0,
CO2 is sent from WS1 {"time": "2024-04-02 03:24:46", "co2": 350.2}
Weather is sent from WS1 {"time": "2024-04-02 03:24:48", "temperature": 23.8,
CO2 is sent from WS1 {"time": "2024-04-02 03:24:50", "co2": 337.3}
Weather is sent from WS1 {"time": "2024-04-02 03:24:52", "temperature": 11.6,
CO2 is sent from WS1 {"time": "2024-04-02 03:24:54", "co2": 388.7}
Weather is sent from WS1 {"time": "2024-04-02 03:24:56", "temperature": 10.5,
CO2 is sent from WS1 {"time": "2024-04-02 03:24:58", "co2": 310.4}
Weather is sent from WS1 {"time": "2024-04-02 03:25:00", "temperature": 9.3, "
CO2 is sent from WS1 {"time": "2024-04-02 03:25:02", "co2": 481.1}
Weather is sent from WS1 {"time": "2024-04-02 03:25:04", "temperature": 34.7,
CO2 is sent from WS1 {"time": "2024-04-02 03:25:06", "co2": 477.0}
Weather is sent from WS1 {"time": "2024-04-02 03:25:08", "temperature": 7.4, "
CO2 is sent from WS1 {"time": "2024-04-02 03:25:10", "co2": 344.8}
Weather is sent from WS1 {"time": "2024-04-02 03:25:12", "temperature": 13.5,
CO2 is sent from WS1 {"time": "2024-04-02 03:25:14", "co2": 427.5}
^CTerminating weather station
```

```
$ python process_weather.py
Received weather data: weather {"time": "2024-04-02 03:24:40", "temperature":
Received weather data: weather {"time": "2024-04-02 03:24:44", "temperature":
Received weather data: weather {"time": "2024-04-02 03:24:48", "temperature":
The last 30 sec average Temperature is 27.37 and Humidity 80.43
Received weather data: weather {"time": "2024-04-02 03:24:52", "temperature":
Received weather data: weather {"time": "2024-04-02 03:24:56", "temperature":
Received weather data: weather {"time": "2024-04-02 03:25:00", "temperature":
Received weather data: weather {"time": "2024-04-02 03:25:04", "temperature":
Received weather data: weather {"time": "2024-04-02 03:25:08", "temperature":
Feel free to wear spring/autumn clothes
Received weather data: weather {"time": "2024-04-02 03:25:12", "temperature":
```

```
$ python process_co2.py
Received weather data: co2 {"time": "2024-04-02 03:24:42", "co2": 461.7}
Danger Zone! Please do not leave home
Received weather data: co2 {"time": "2024-04-02 03:24:46", "co2": 350.2}
Received weather data: co2 {"time": "2024-04-02 03:24:50", "co2": 337.3}
Received weather data: co2 {"time": "2024-04-02 03:24:54", "co2": 388.7}
Received weather data: co2 {"time": "2024-04-02 03:24:58", "co2": 310.4}
Received weather data: co2 {"time": "2024-04-02 03:25:02", "co2": 481.1}
Danger Zone! Please do not leave home
Received weather data: co2 {"time": "2024-04-02 03:25:06", "co2": 477.0}
Danger Zone! Please do not leave home
Received weather data: co2 {"time": "2024-04-02 03:25:10", "co2": 344.8}
Received weather data: co2 {"time": "2024-04-02 03:25:14", "co2": 427.5}
Danger Zone! Please do not leave home
^CTerminating data_processor
```

```
$ python client.py
Enter your query (Fashion/Weather): Weather
Sending query: Weather
Received response: The last 30 sec average Temperature is 27.37 and Humidity 8
Enter your query (Fashion/Weather): sth
Invalid query. Please enter 'Fashion' or 'Weather'.
Enter your query (Fashion/Weather): Fashion
Sending query: Fashion
Received response: Feel free to wear spring/autumn clothes
Enter your query (Fashion/Weather): ^CTerminating client
```

Checklist

- [ ] A single submitted file `NameSurname.zip` with the following content inside:

```
├── process_weather.py
├── process_co2.py
└── weather_station.py
```

- **Weather Station**
  - [ ] Generate and send `Weather data` successfully. (1.5)
  - [ ] Generate and send `CO2 data` successfully. (1.5)
- **Weather Processing Server**
  - [ ] Implement threading for concurrent operation. (1.0)
  - [ ] Receive **only** weather data from weather station. (1.0)
  - [ ] Calculate and maintain the average temperature and humidity. (0.5)
  - [ ] Receive requests from the client ("Fashion" and "Weather") and respond accurately. (2.0)
  - [ ] Save received weather data in weather_data.log (0.5)
- **CO2 Processing Server**
  - [ ] Receive **only** CO2 data from weather station and print a danger message if CO2 level exceeds 400 ppm. (1.0)
  - [ ] Save received CO2 data in co2_data.log. (0.5)
- [ ] Ensure each program runs until an interrupt is received (i.e., **KeyboardInterrupt** is handled). (0.5)

- [ ] Source code is the author's original work. *(-10 points and case submission to DOE for non-compliance, both parties will be penalized for detected plagiarism)*