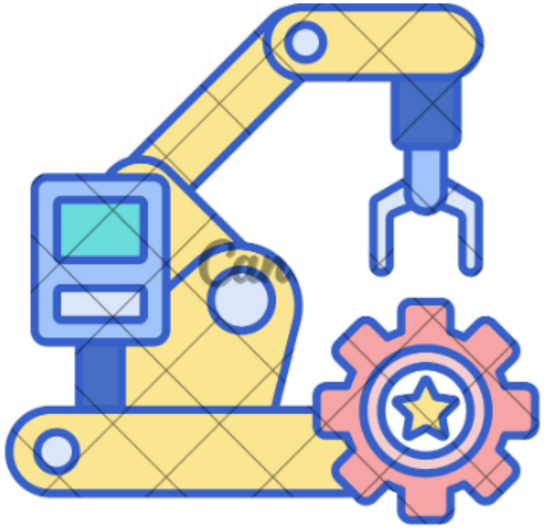
Envi-Optimizer

T2G2

Jin Bin | Alex | Habib | Min

The Problem ...



Smart Factories

Human Involvement

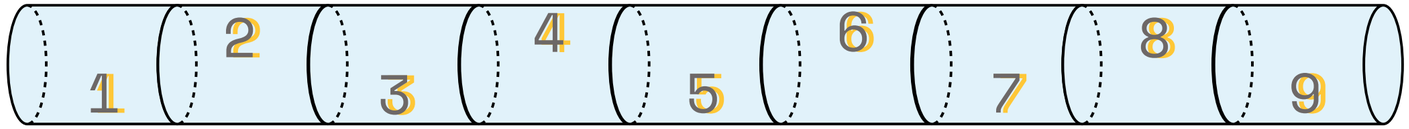
Machines
+
Human

Our Solution

Environmental Monitoring

Efficiency
+
Sustainability

Data Pipeline



Success criteria ...

Data:	Accurate collection and analysis of data will be carried out in five phases: collection, pre-processing, storage, exploration, and analysis.
Security:	Prioritizing data security is crucial to protect the collected sensor data and end results against malicious theft.
Refinement:	To exceed stakeholder expectations, further enhancements to the project are suggested, such as monitoring of the intelligent control systems and cloud storage infrastructure.

Goals

1

Improve the efficiency and safety of advanced manufacturing facilities -

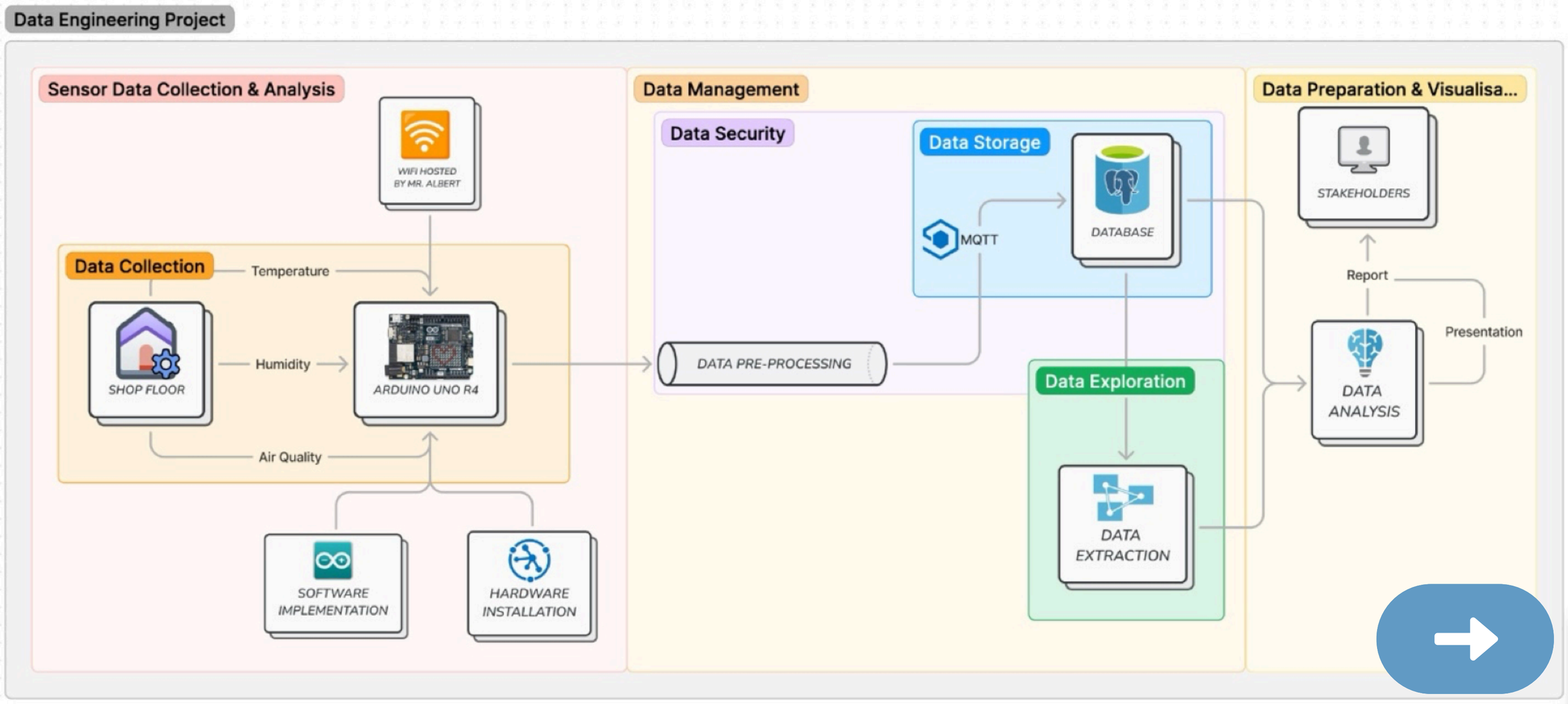
-> temperature, humidity, and air quality

2

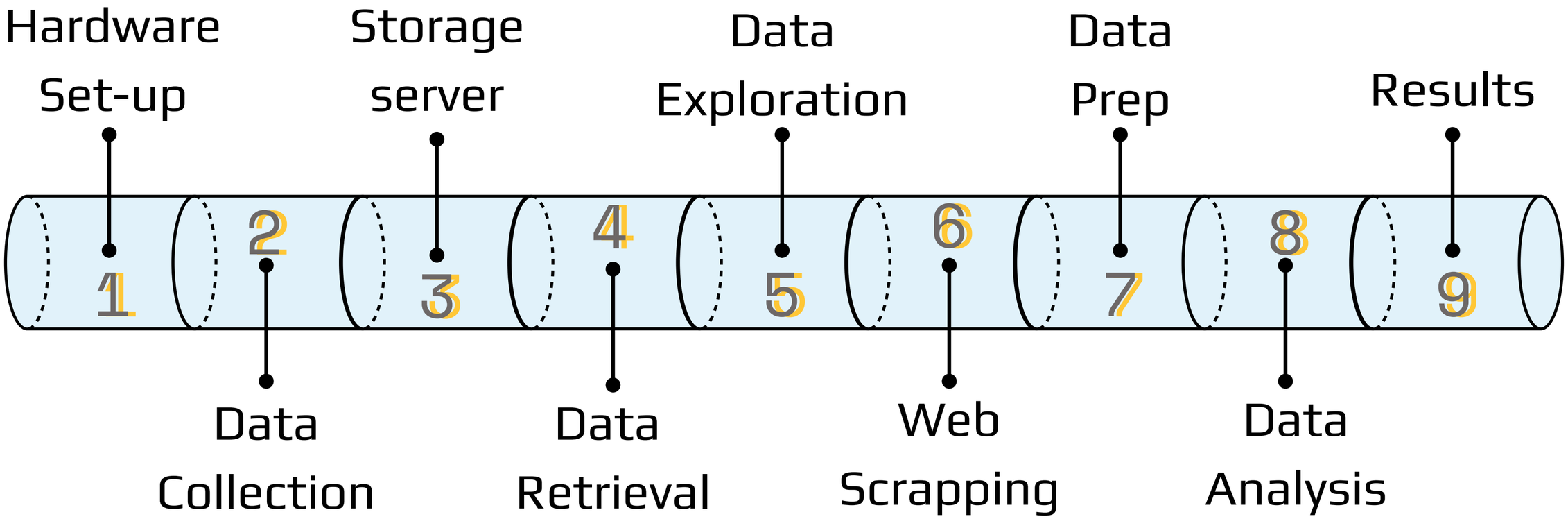
Analyze data from Device01 and weather conditions

Gain deeper insights into how external factors affect would affect the factory environment

Design Architecture

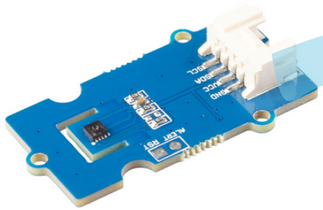


Data Pipeline

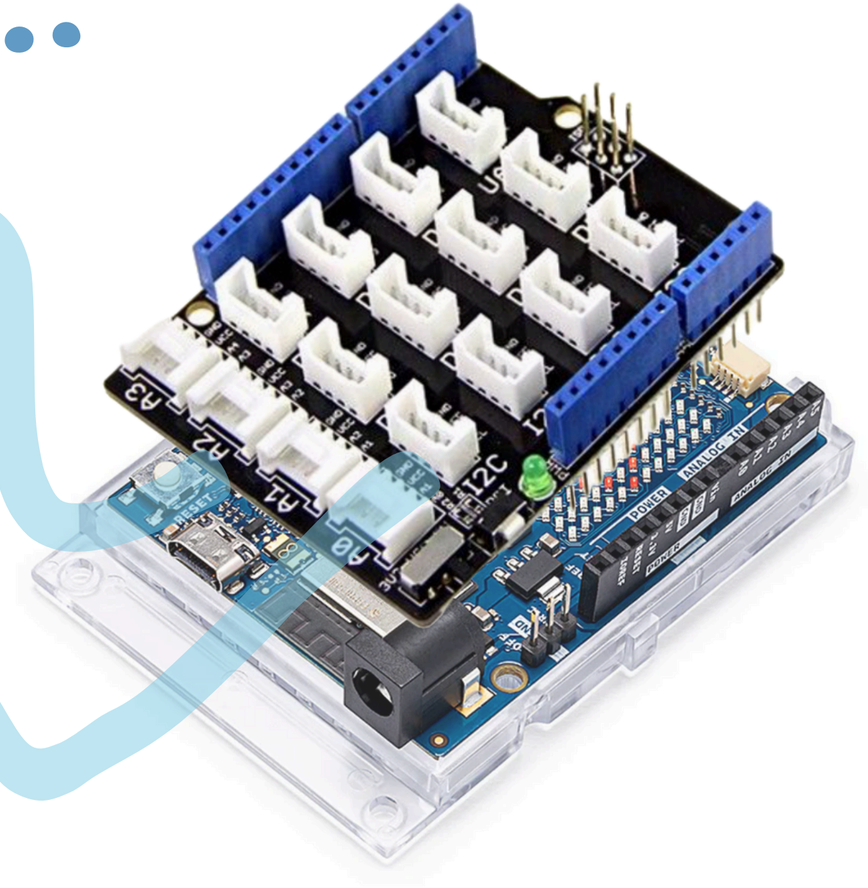


Hardware...

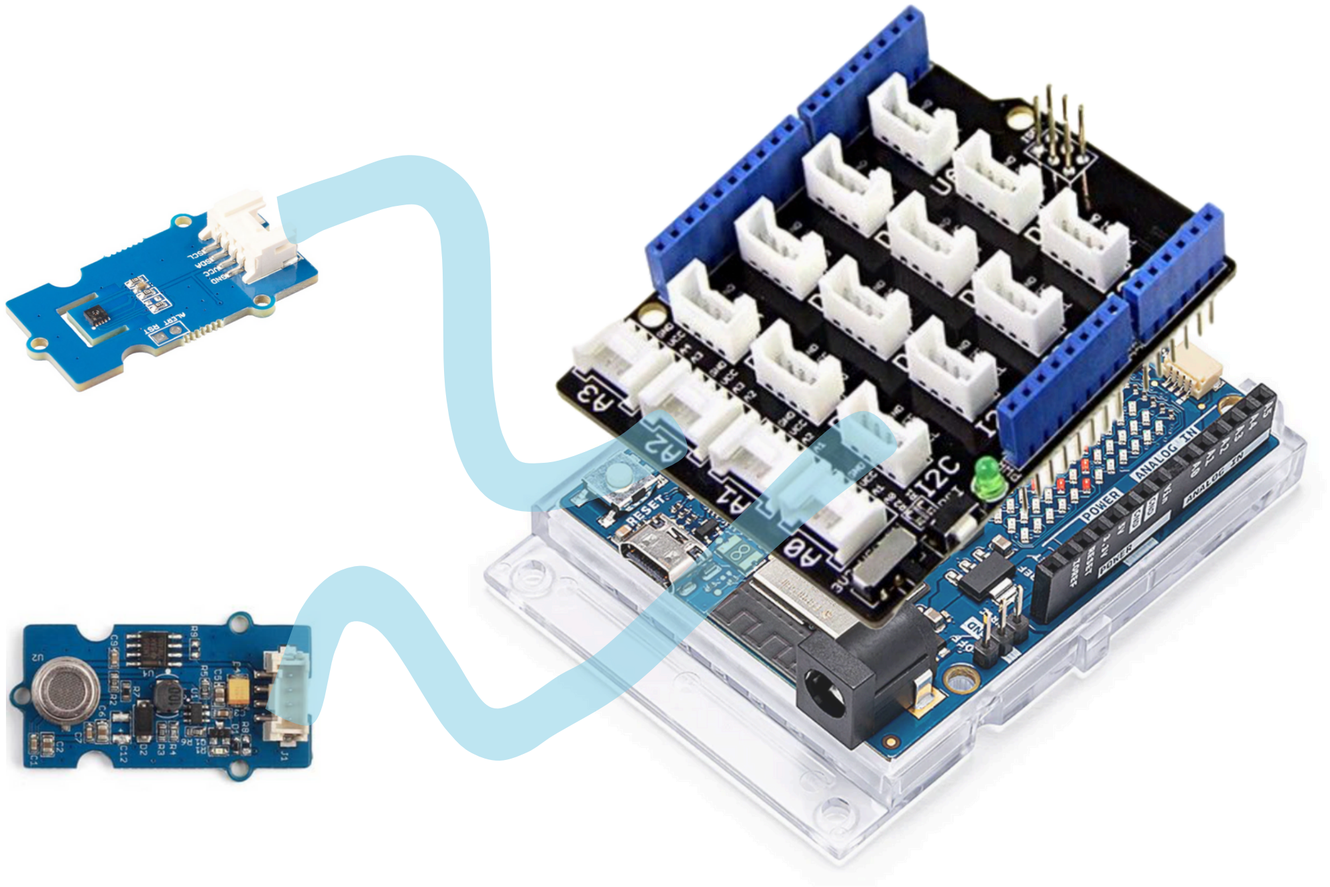
Grove High Accuracy Temperature & Humidity Sensor
Analog: A2



Grove Air Quality Sensor
I2C



Arduino Uno R4 WiFi
256 kB flash,
32 kB SRAM,
8 kB of EEPROM,
WiFi Module included



Hardware Set-up

Data Collection...

Temperature

Humidity

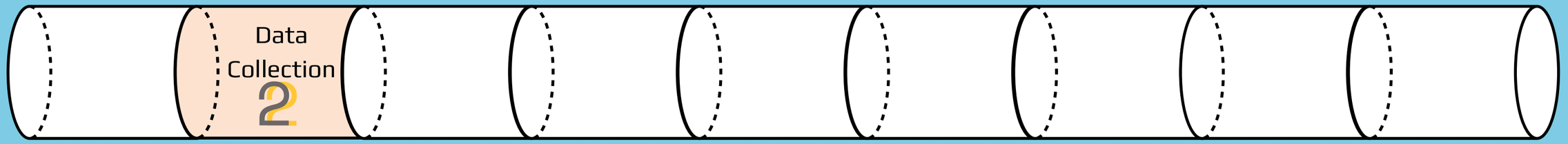
Air Quality

Measure

&

Publish

t2g2:114,24.40;62.45;24;Min;



Data Collection ...

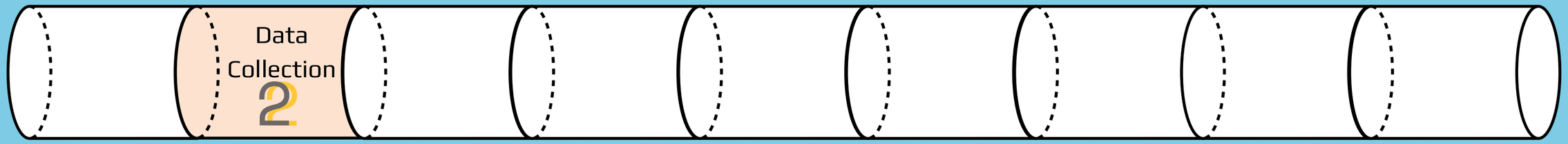
DEP_diff

DEP_mov_avg

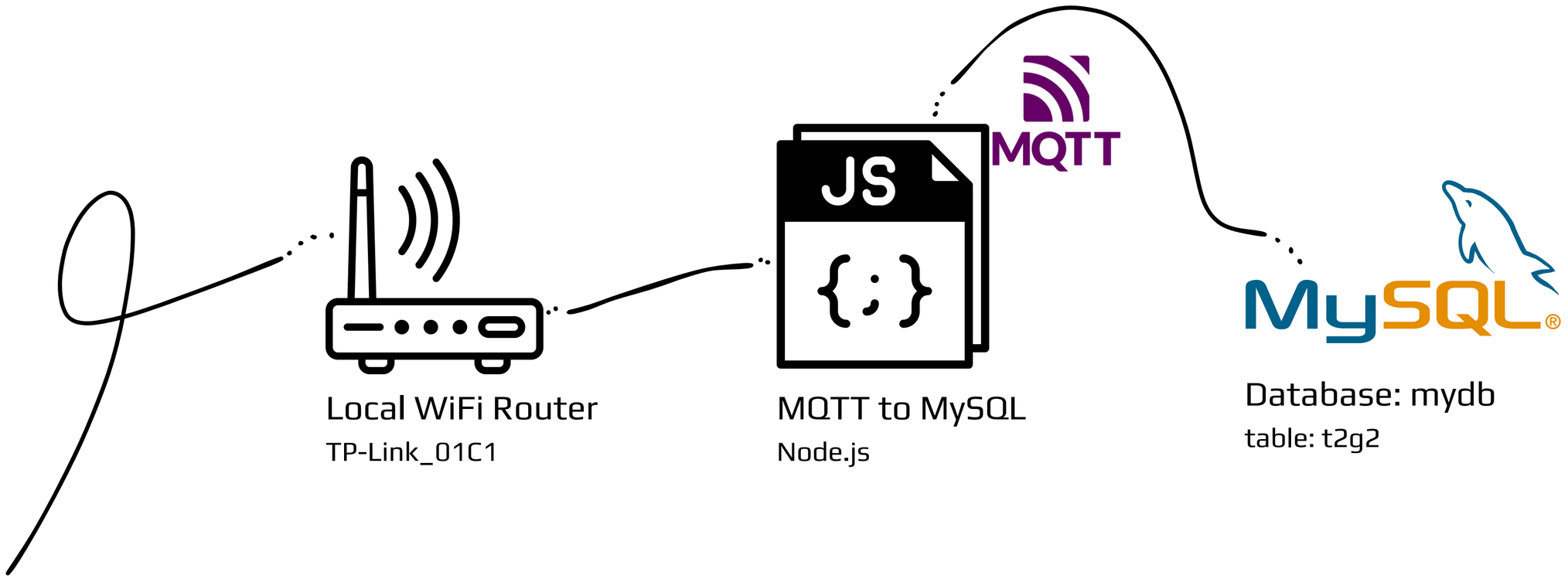
DEP_normal

DEP_normal.ino

```
1   //***temp, hum, air***
2
3   //air quality sensor
4   #include "Air_Quality_Sensor.h"
5   AirQualitySensor sensor2(A0);
6
7   //temp-hum sensor
8   #include "Seeed_SHT35.h"
9   #ifdef ARDUINO_SAMD_VARIANT_COMPLIANCE
10    #define SDAPIN  20
11    #define SCLPIN  21
12    #define RSTPIN  7
13    #define SERIAL SerialUSB
14  #else
15    #define SDAPIN  A4
16    #define SCLPIN  A5
17    #define RSTPIN  2
18    #define SERIAL Serial
19  #endif
20  SHT35 sensor(SCLPIN);
21
22  //wifi & mqtt
23  #include <ArduinoMqttClient.h>
24  #if defined(ARDUINO_SAMD_MKRWIFI1010) || defined(ARDUINO_SAMD_NANO_33_IOT) || defined(ARDUINO_AVR_UNO_WIFI_REV2)
25    #include <WiFiNINA.h>
26  #elif defined(ARDUINO_SAMD_MKR1000)
```



Storage Server ...



Local WiFi Router

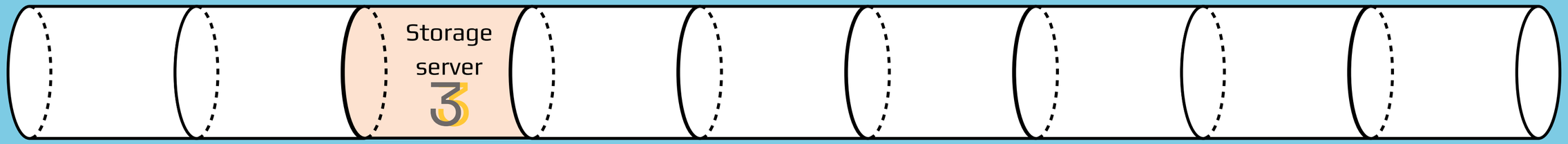
TP-Link_01C1

MQTT to MySQL

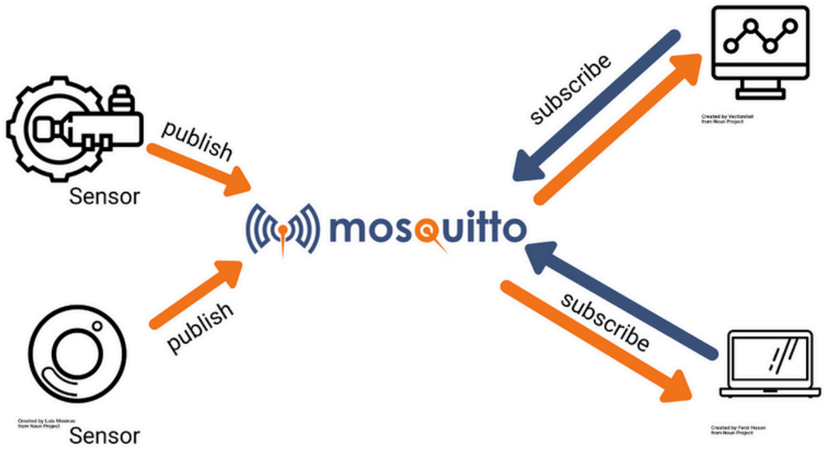
Node.js

Database: mydb

table: t2g2



Data Retrieval ...



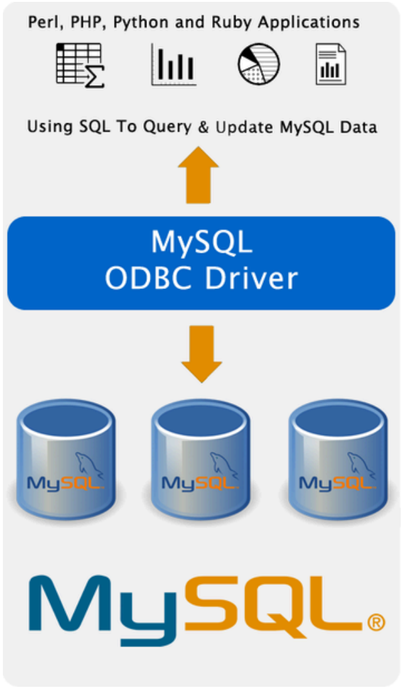
mosquittp MQTT

Terminal

python™ + MySQL®

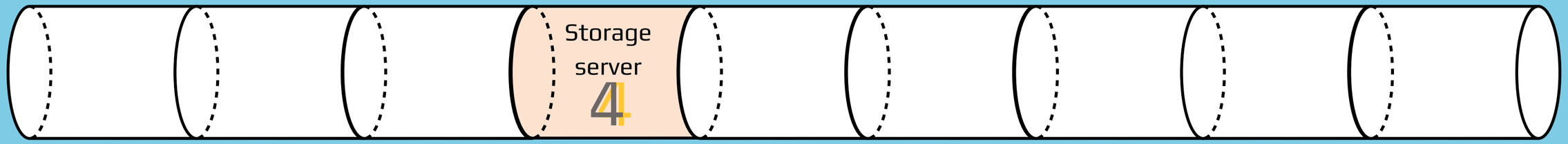
MySQL Connector

Python



MySQL ODBC Driver

Power BI



Project Scope

Included

- Installation of hardware components along with functional software
- Regular monitoring and collection of transmitted data, ideally twice a week
- Analysis of the collected data and a final report
- Recommendations for further improvements

Excluded

- Actual optimization and measuring the effectiveness of the resultant parameters are not carried out.
- Recommendations for further improvements will not be executed without specific instructions.

Limitation

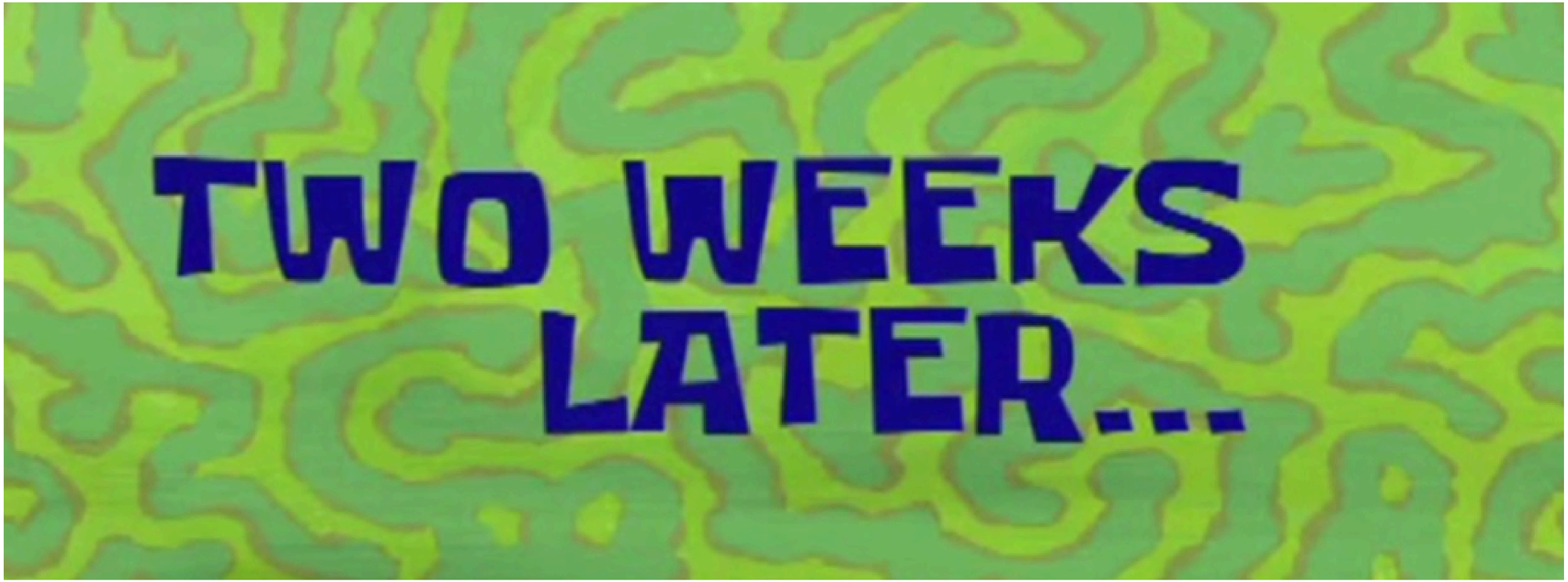
- Only one set of hardware will be provided, and any misuse or malfunction of the sensors will be resolved by the engineers.
- The quality of the data is contingent upon the accuracy and reliability of the sensors, assuming that data pre-processing is executed effectively.
- The stored data in the server can only be accessed when connected to the same network, i.e., in close proximity to the shop floor.

Boundary

- This project aims to determine the ideal parameters to aid in the decision-making of optimizing the shop floor environment.
- Conclusions derived from temperature, humidity, and air quality data will be outlined in the final report.

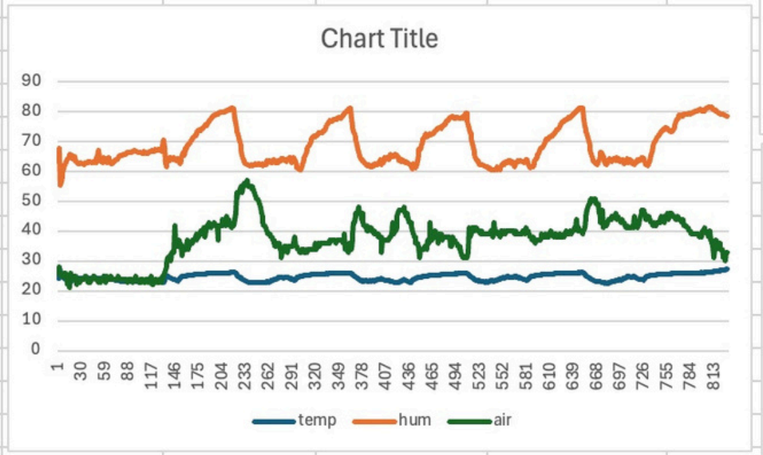
Limitation

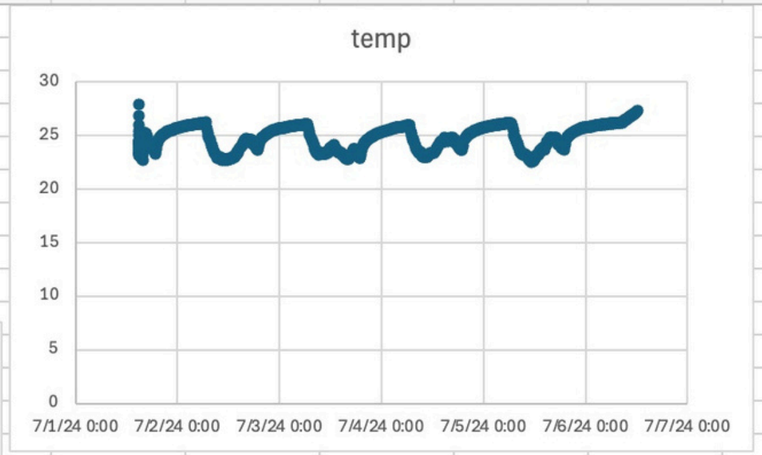
The air quality sensor is not very accurate. Although the code includes labels for quality categories, we used the exact values instead

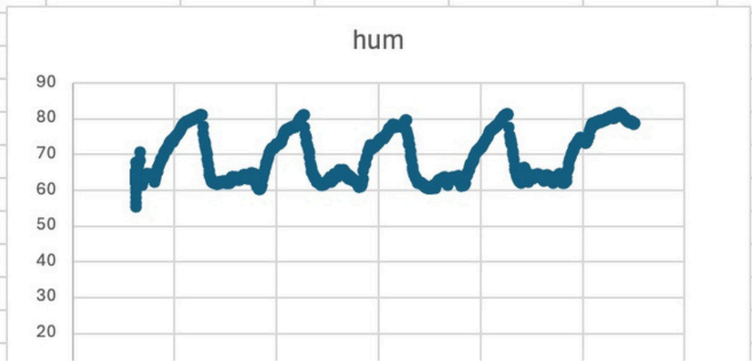

TWO WEEKS
LATER...

Data Exploration

Row Labels	Average of air	Average of hum	Average of temp
<7/1/24			
1-Jul	26.90555556	65.42461111	24.05327778
2-Jul	41.33333333	68.71631944	24.64458333
3-Jul	39.11111111	68.80534722	24.445
4-Jul	38.18055556	67.82916667	24.71638889
5-Jul	43	69.14284722	24.73423611
6-Jul	39.4109589	79.02369863	26.23561644
Grand Total	37.38721351	68.8446924	24.64967431







Example of our weekly data exploration

Web Scrapping ...

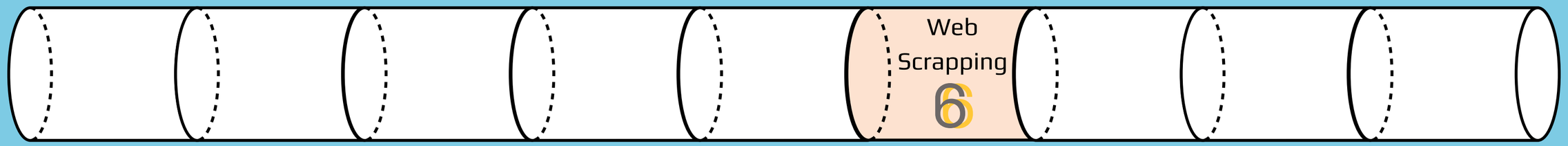
timeanddate.com

Ang Mo Kio New Town

	Conditions			Comfort			
Time	Temp	Weather	Wind	Humidity	Barometer	Visibility
00:00 Mon, 1 Jul	26 °C	Passing clouds.	4 km/h ↘	89%	1012 mbar	N/A
01:00	26 °C	Passing clouds.	2 km/h →	89%	1011 mbar	N/A
02:00	26 °C	Passing clouds.	2 km/h ↙	89%	1010 mbar	N/A
03:00	26 °C	Passing clouds.	4 km/h ↙	89%	1010 mbar	N/A
04:00	26 °C	Passing clouds.	4 km/h ↙	89%	1010 mbar	9 km
05:00	26 °C	Passing clouds.	6 km/h ↘	89%	1010 mbar	N/A
06:00	26 °C	Passing clouds.	2 km/h ↙	89%	1010 mbar	N/A

Beautiful Soup

	timestamp	temp	hum	description
0	2024-07-01 00:00:00	26.0	89.0	Passing clouds.
1	2024-07-01 01:00:00	26.0	89.0	Passing clouds.
2	2024-07-01 02:00:00	26.0	89.0	Passing clouds.
3	2024-07-01 03:00:00	25.0	94.0	Passing clouds.
4	2024-07-01 04:00:00	25.0	89.0	Passing clouds.

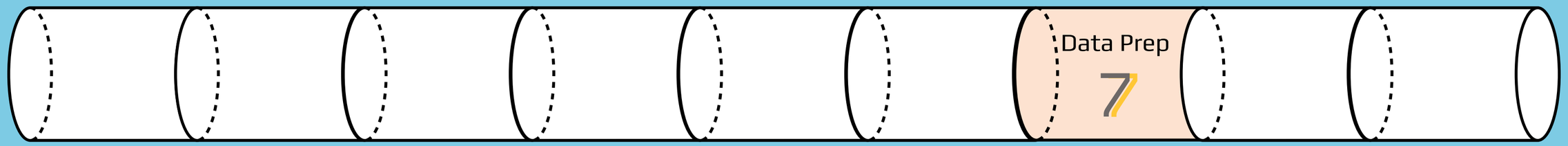


Data Preparation ...

	id	clientID	topic	message	timestamp
0	12	t2g2:114	t2g2	24.19;63.30;26;Min;	2024-07-01 14:50:48
1	13	t2g2:114	t2g2	24.22;65.32;28;Min;	2024-07-01 14:50:58
2	14	t2g2:114	t2g2	27.89;67.87;26;Min;	2024-07-01 14:51:08
3	15	t2g2:114	t2g2	26.81;55.47;26;Min;	2024-07-01 14:51:18
4	16	t2g2:114	t2g2	26.00;56.42;25;Min;	2024-07-01 14:51:28

Split | Null | Duplicates | Resample

timestamp	temp	hum	air
2024-07-01 14:50:00	24.41	62.86	24.86
2024-07-01 15:00:00	24.11	63.60	24.02
2024-07-01 15:10:00	23.14	66.53	23.62
2024-07-01 15:20:00	23.06	67.16	24.00
2024-07-01 15:30:00	22.82	68.51	25.00

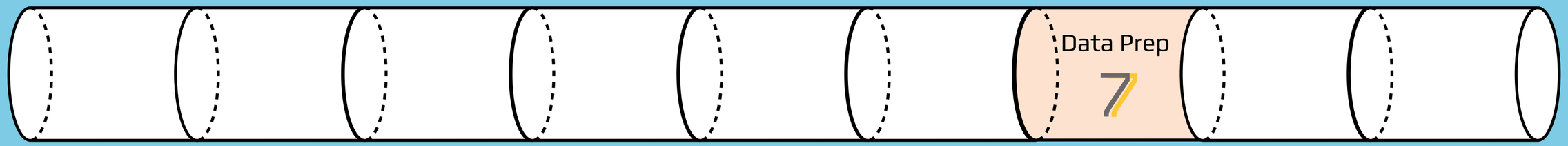


Data Imputation

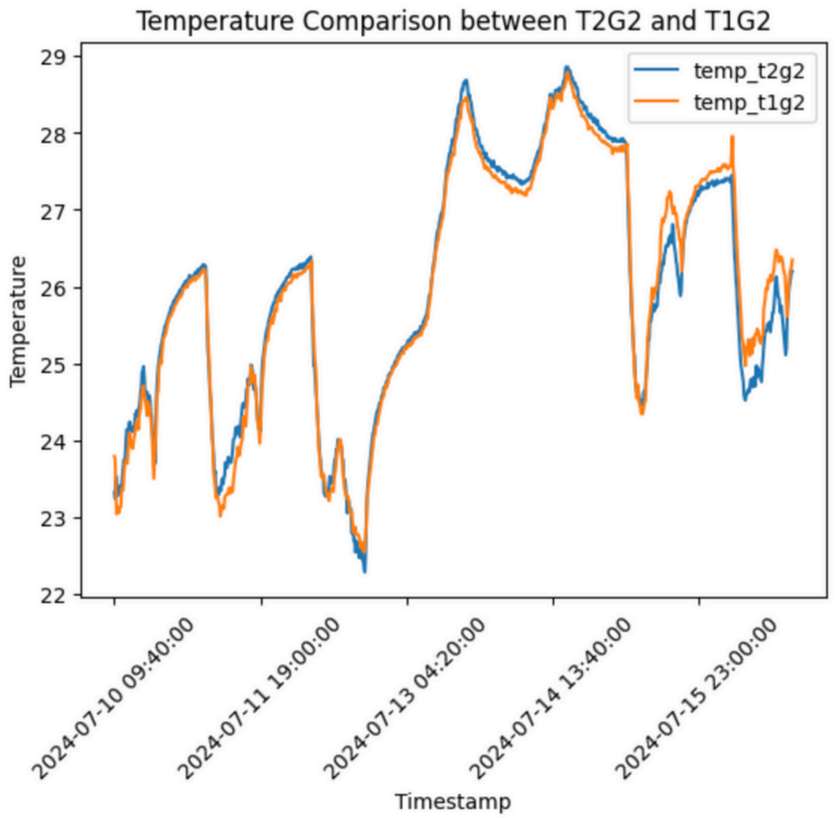
Due to unexpected server issues, we lost a few days worth of data.

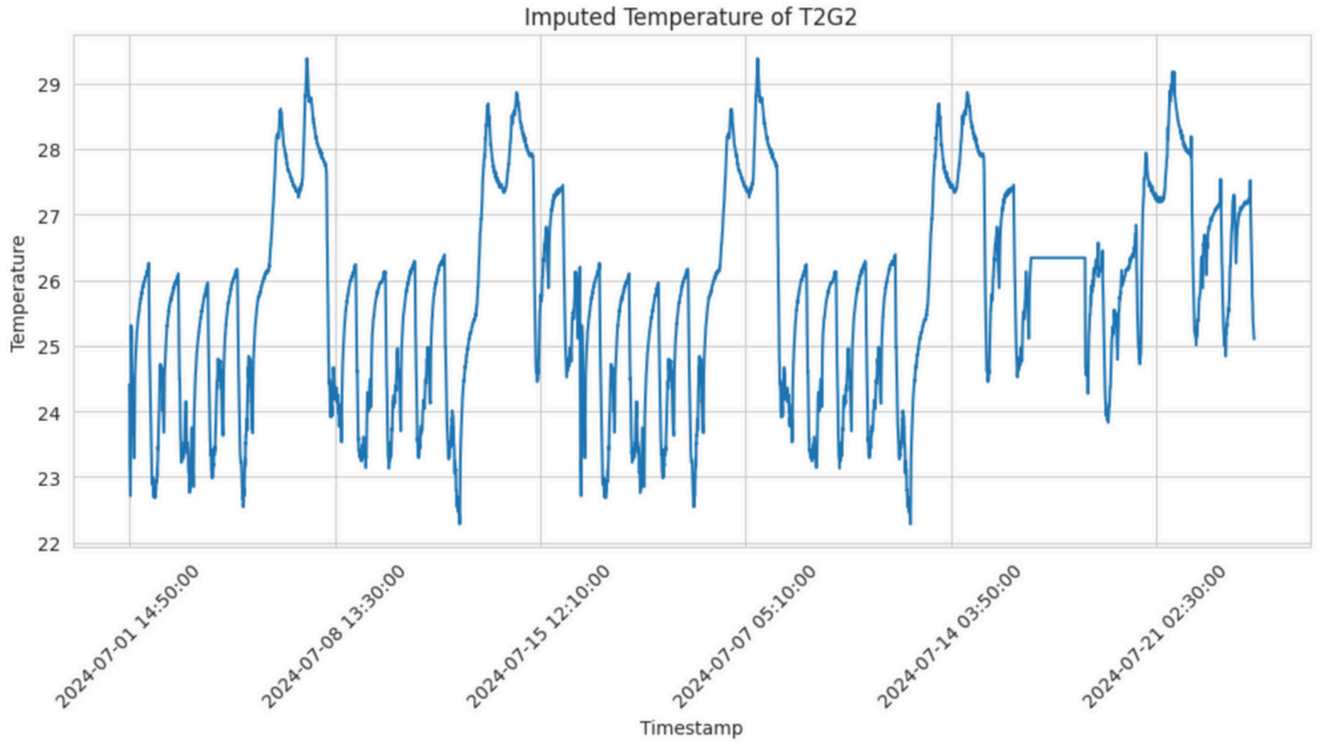
Comparing our data with t1g2, t2g3 and t2g5

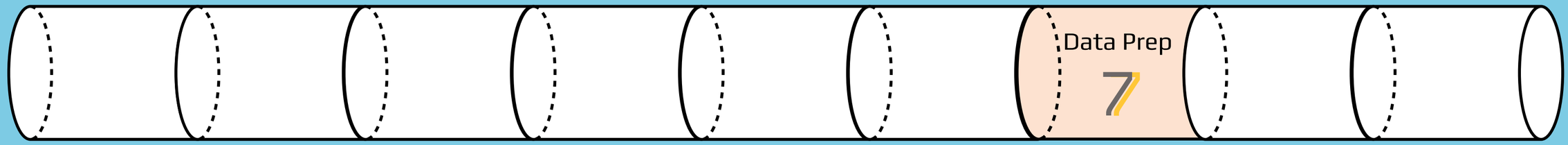
Imputated the data from 16 to 24 July



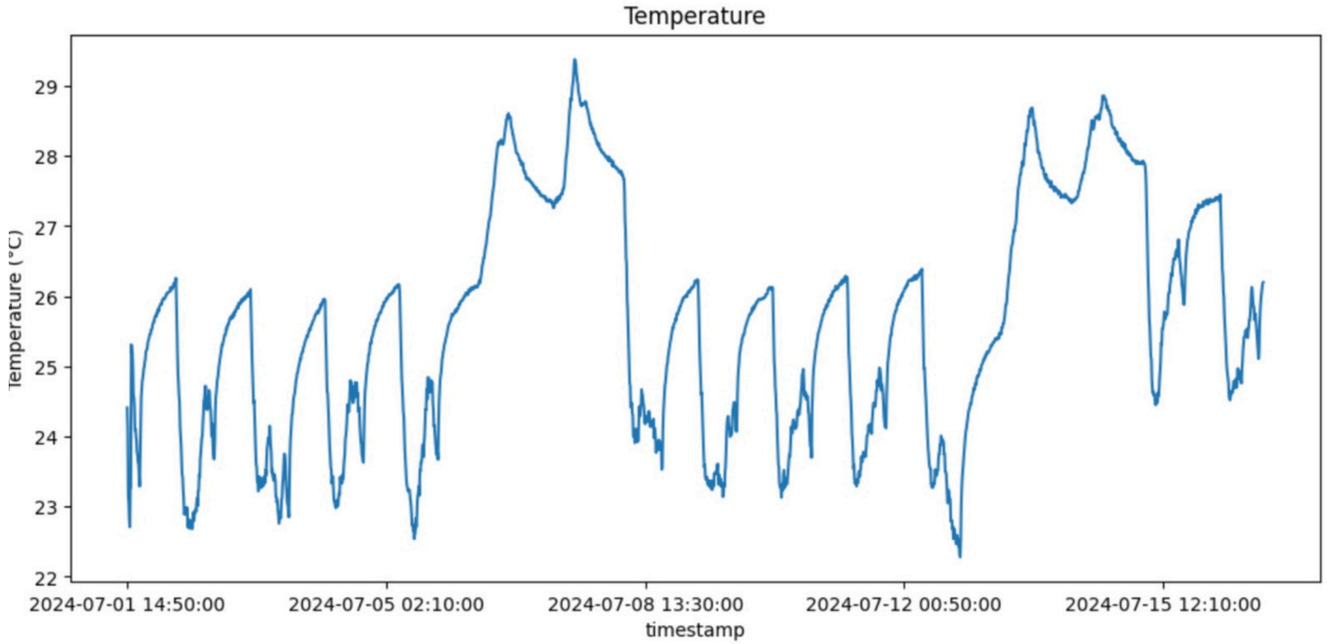
Data Imputation

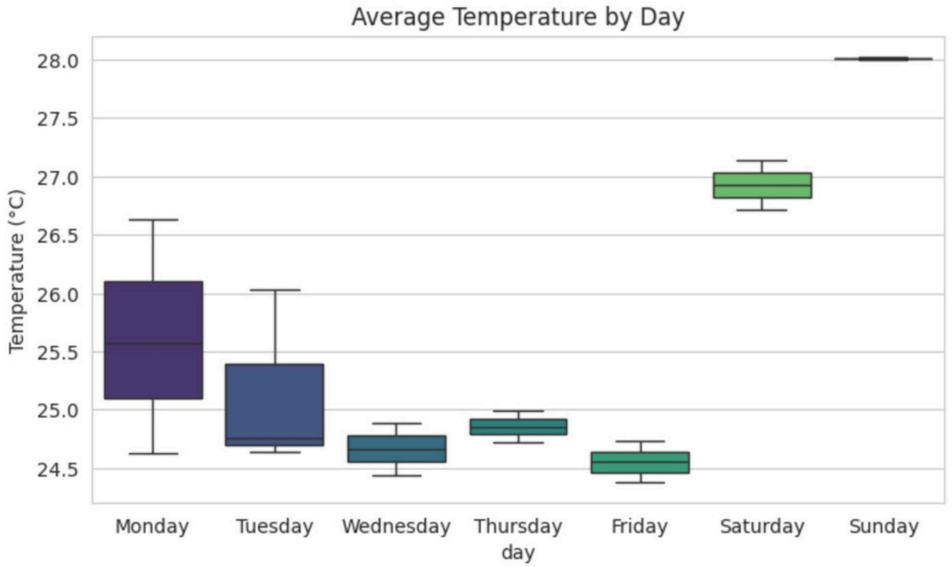




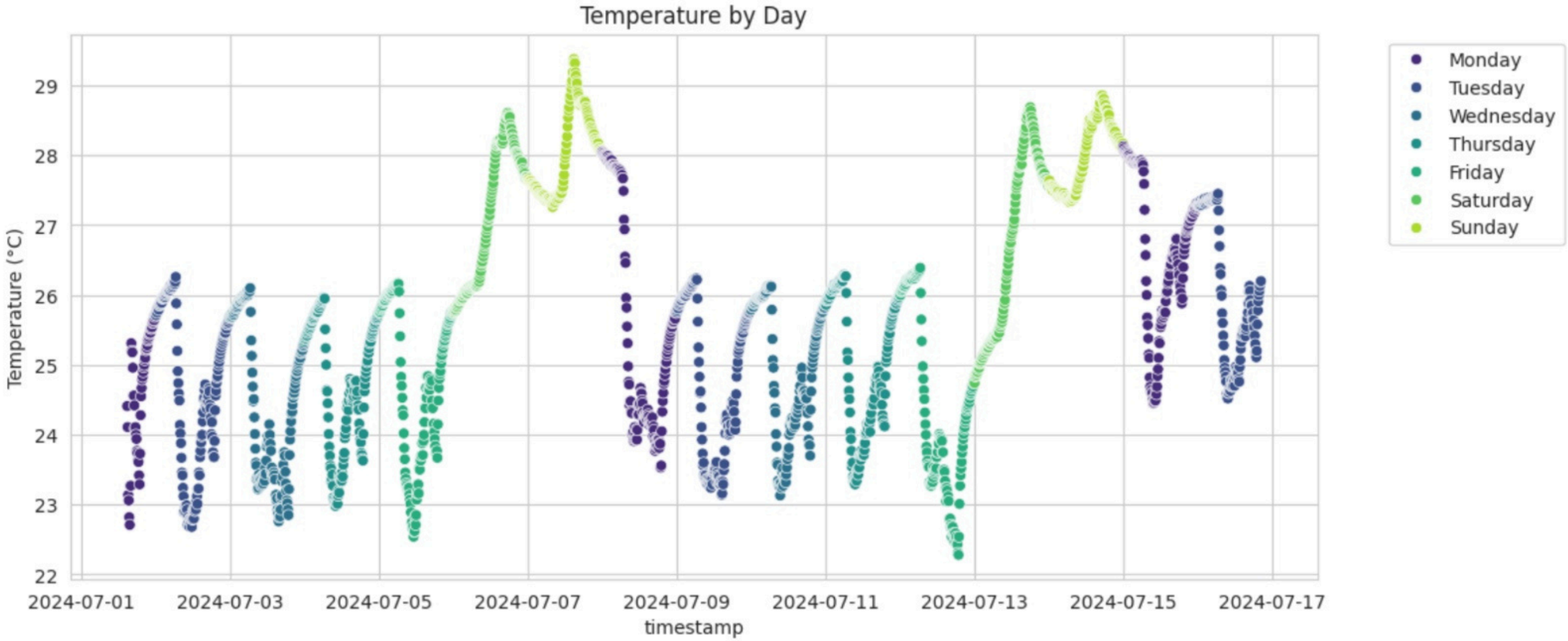


Data analysis (Temperature)

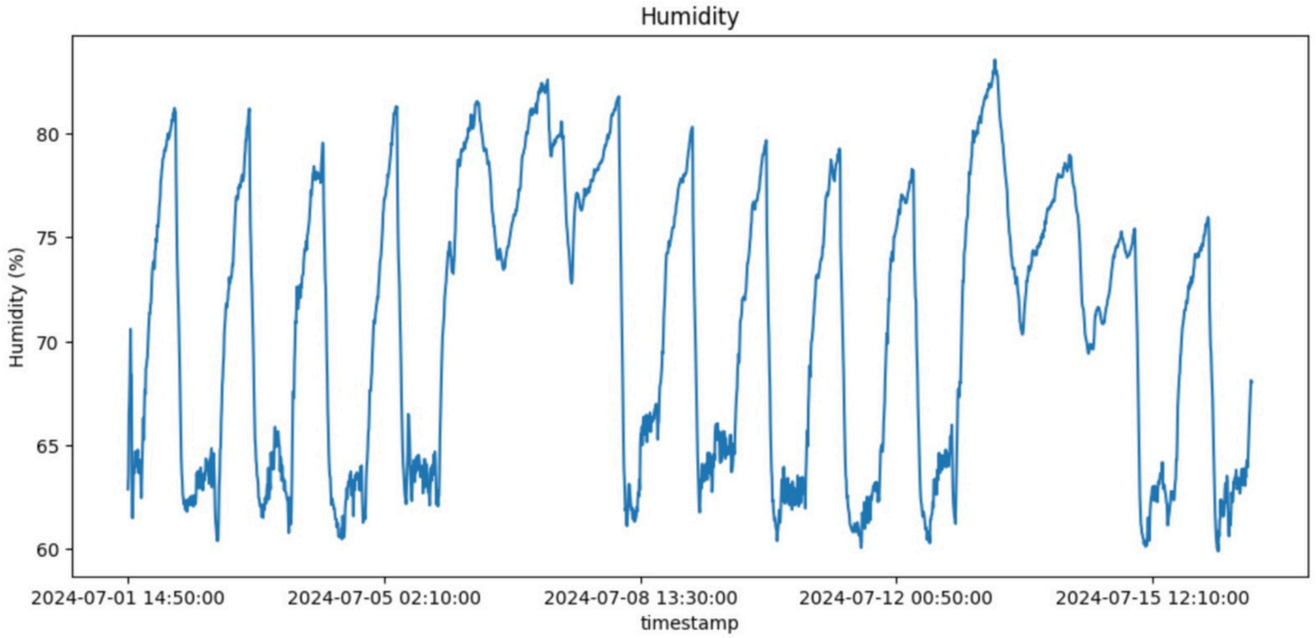


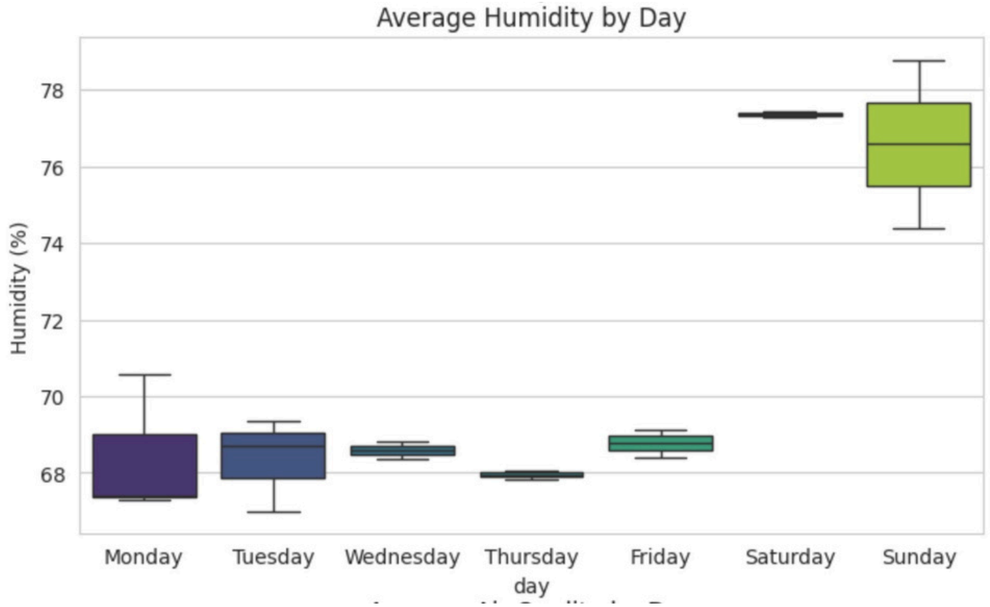


Data analysis (Temperature)

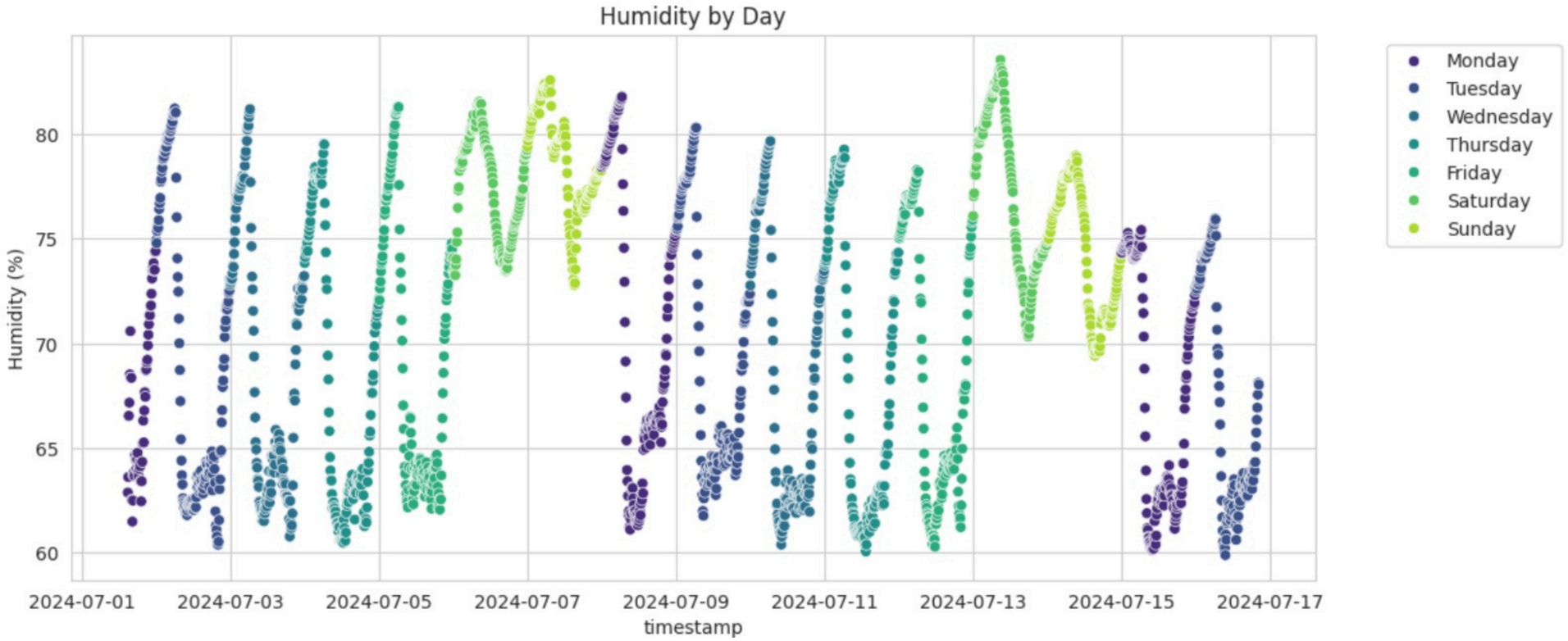


Data analysis (Humidity)

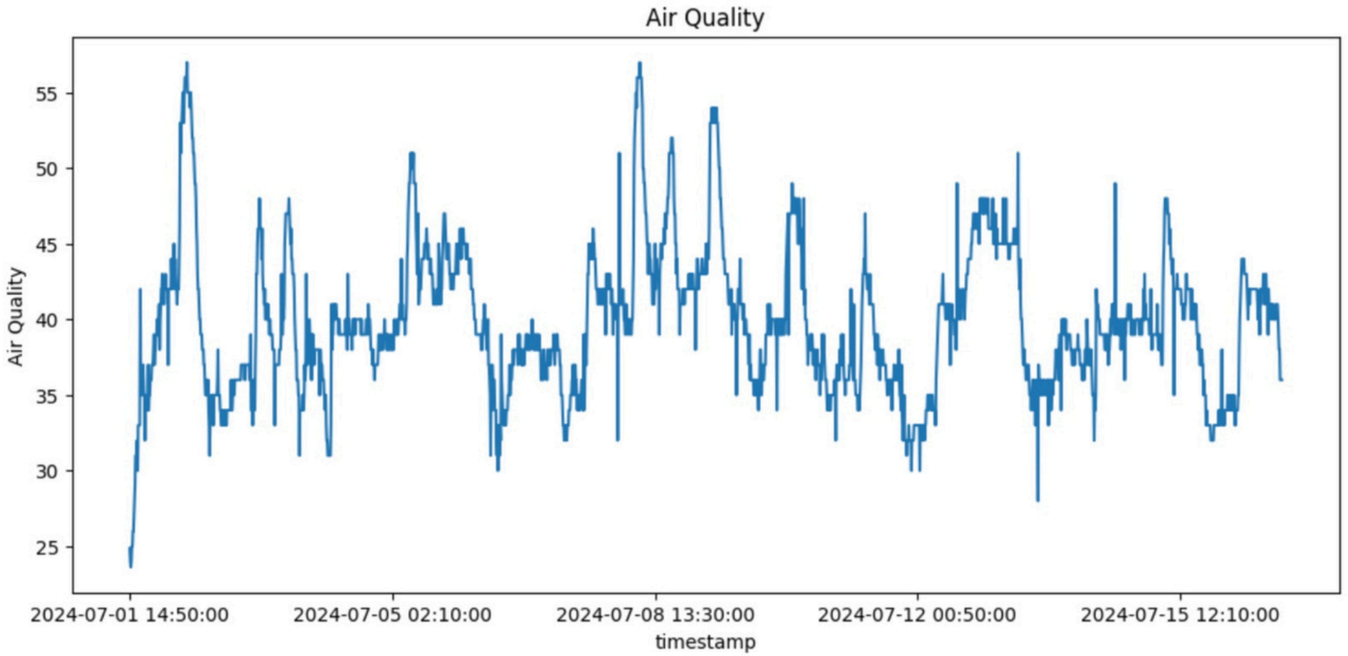


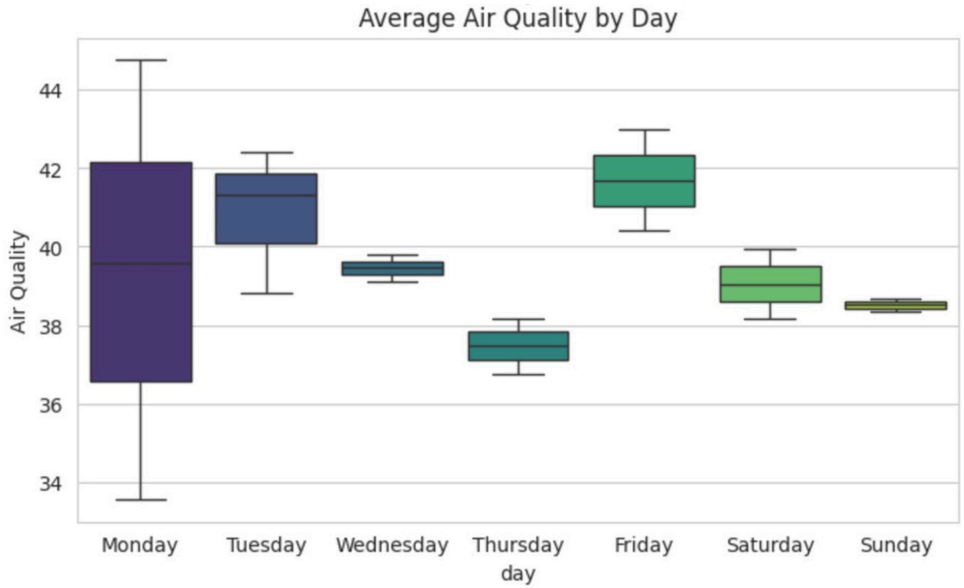


Data analysis (Humidity)

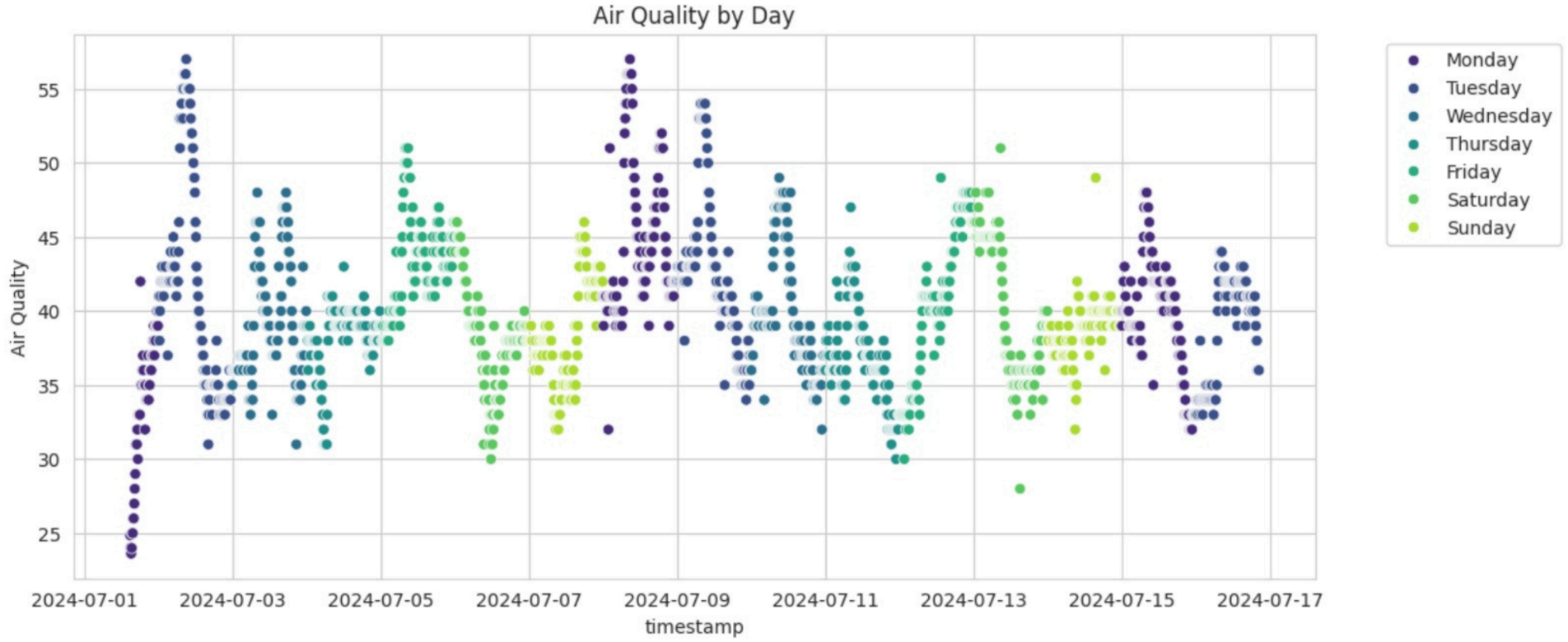


Data analysis (Air quality)

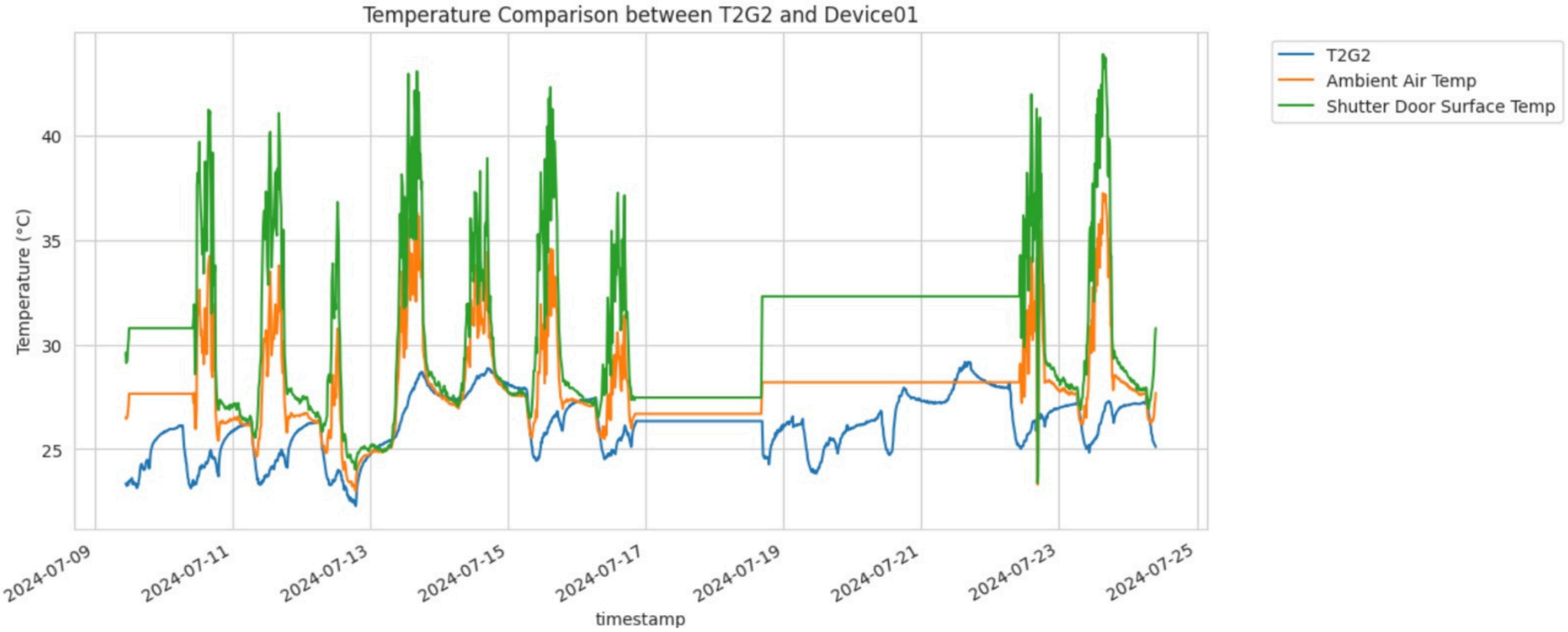




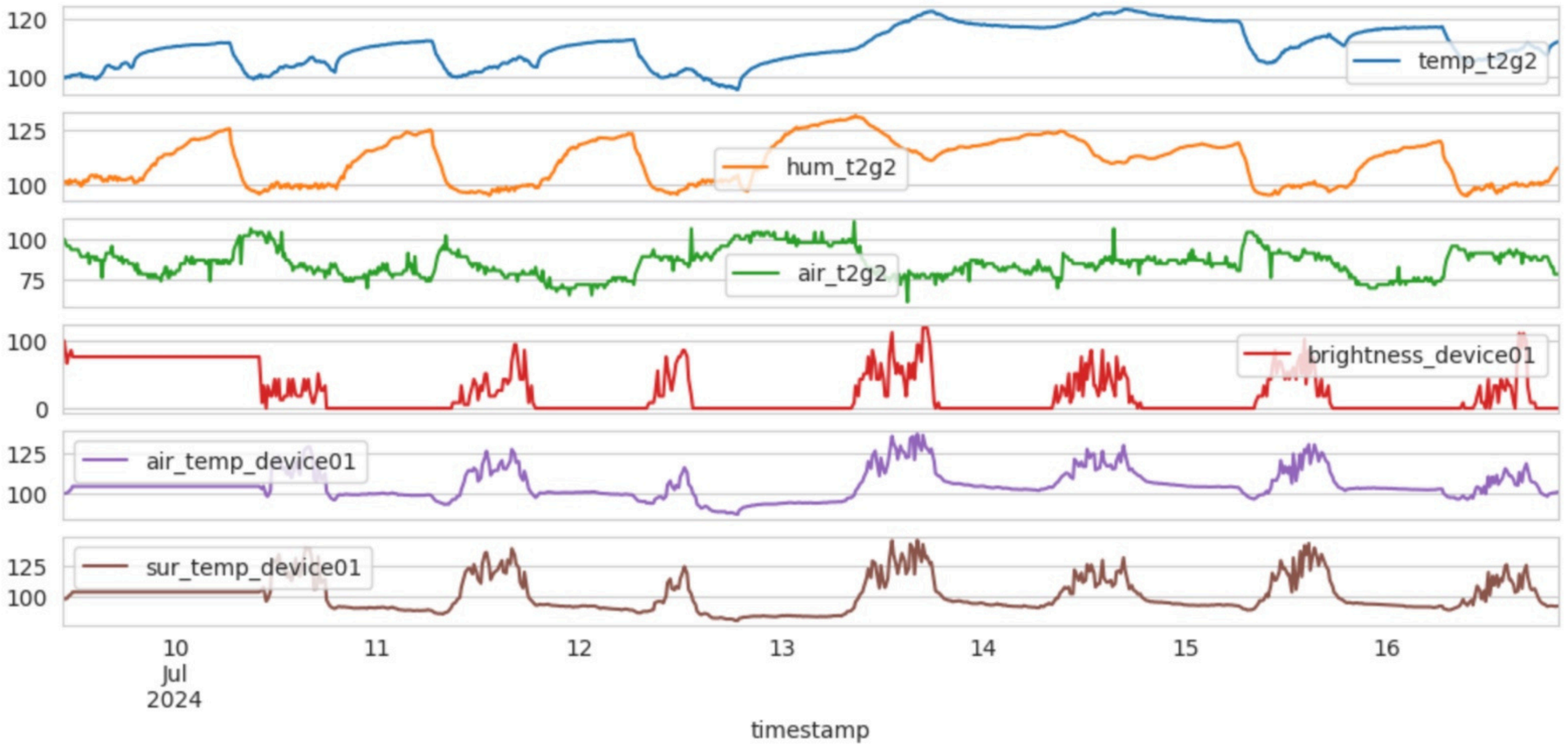
Data analysis (Air quality)



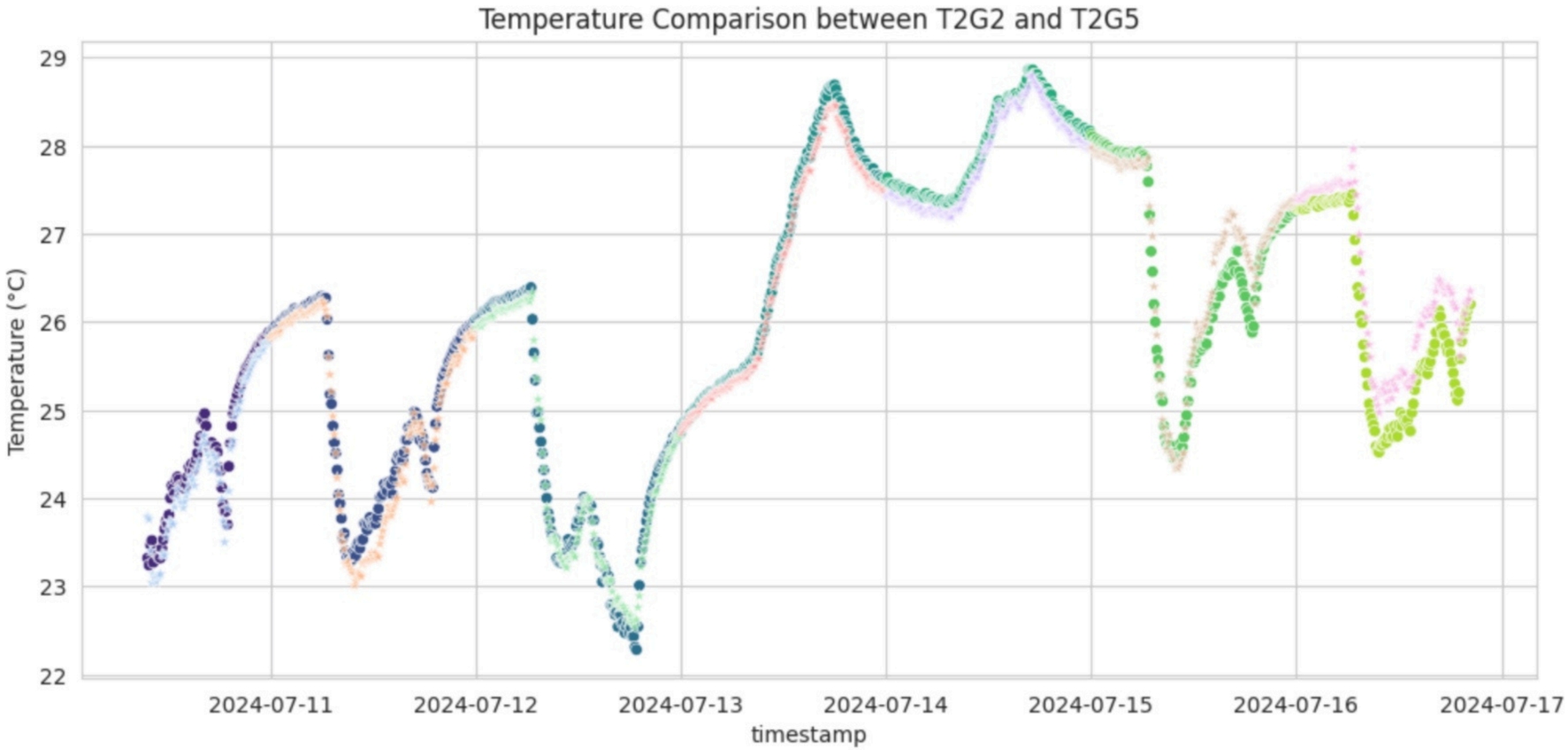
Data analysis ••• Device01



Data analysis ••• Device01

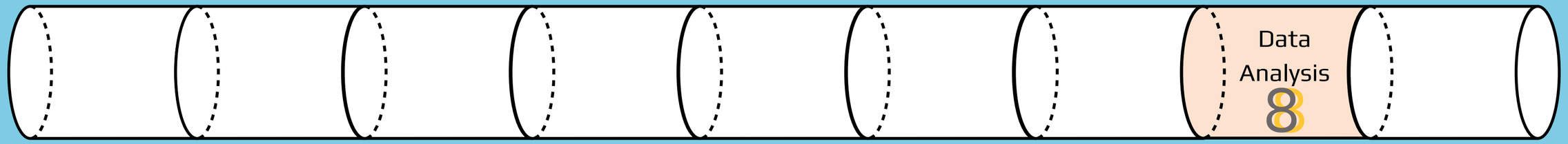


Data analysis ... T2G5

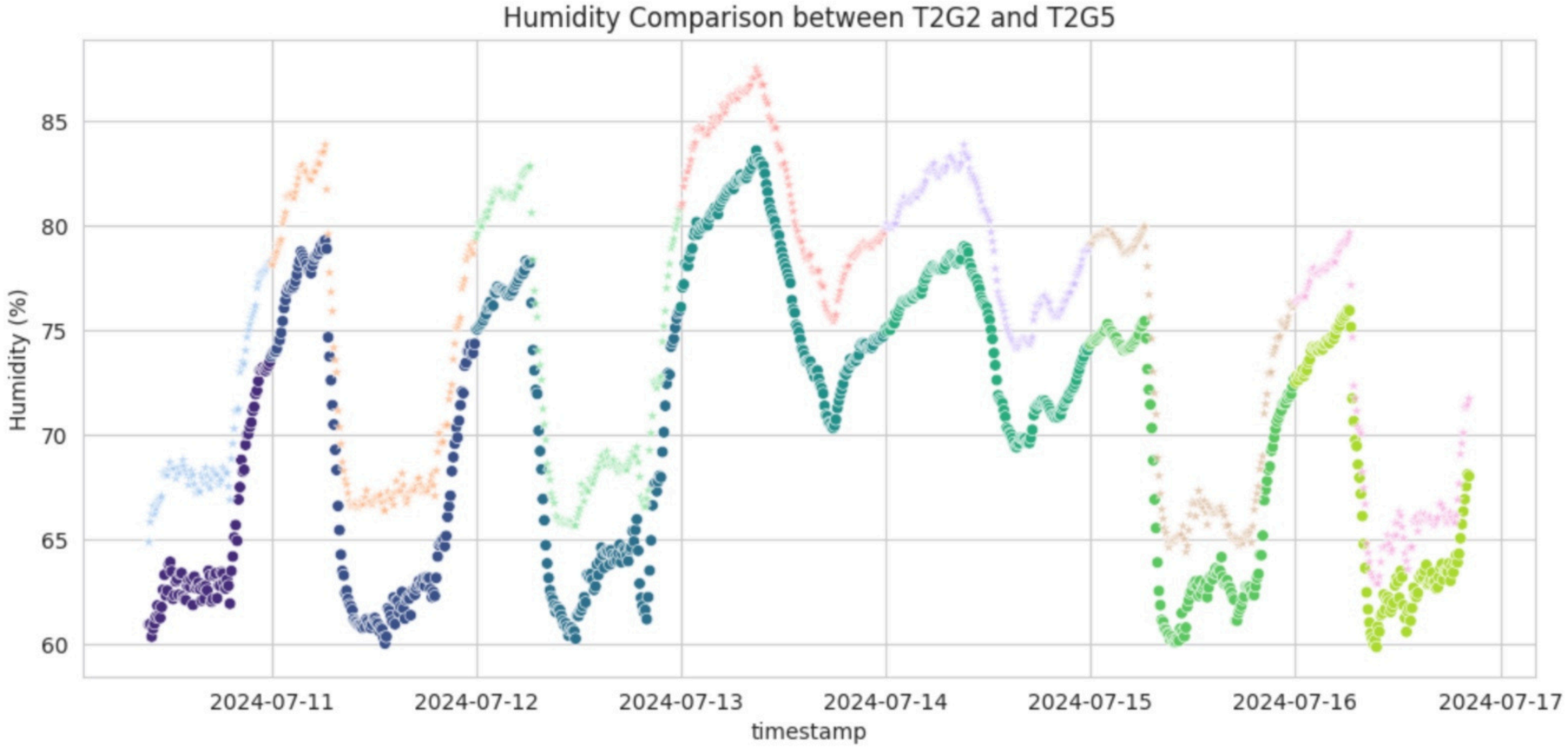


Legend

- stars - t2g5
- dots - t2g2

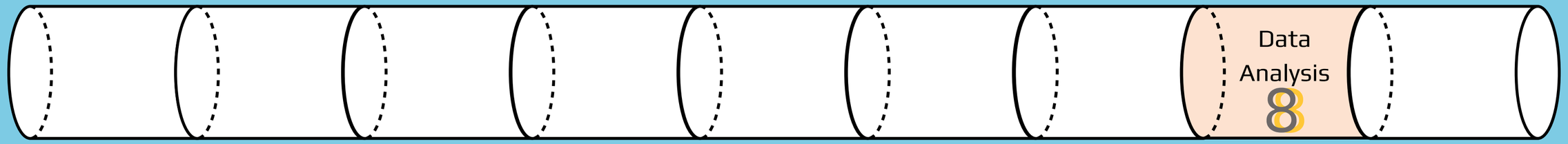


Data analysis ... T2G5

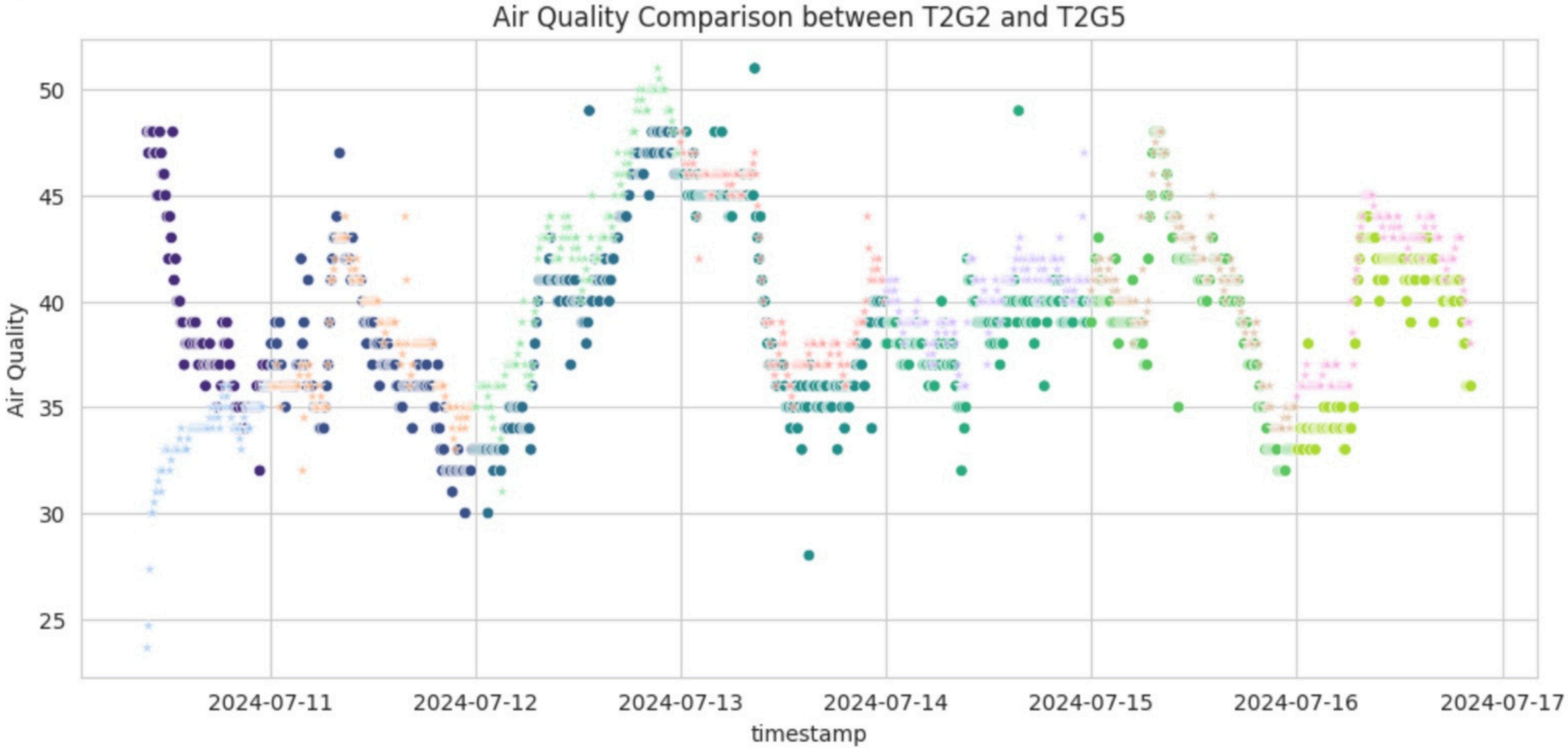


Legend

- stars - t2g5
- dots - t2g2

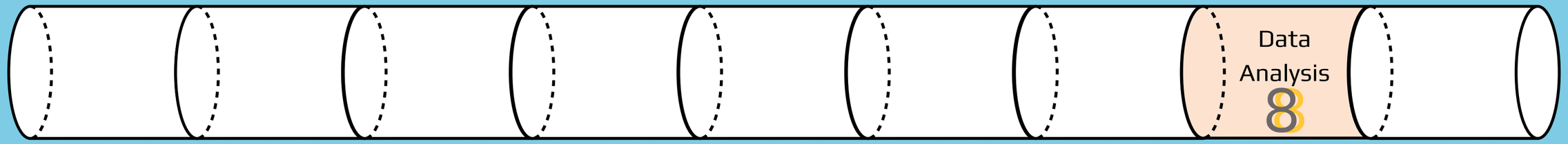


Data analysis ... T2G5

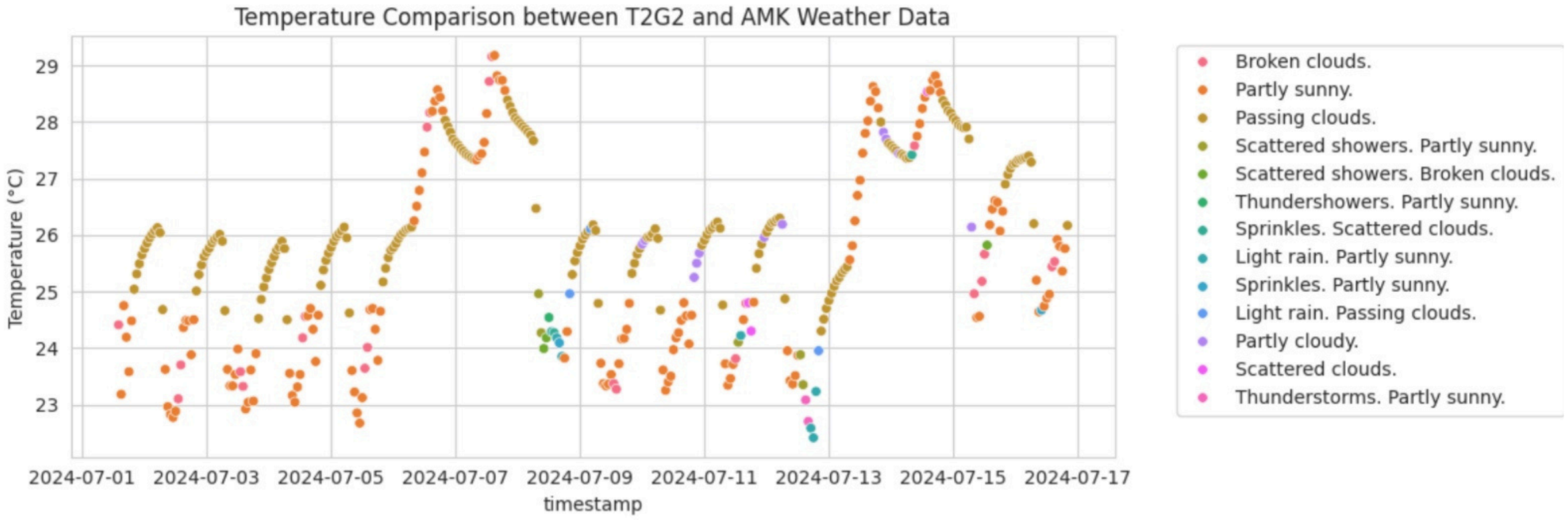


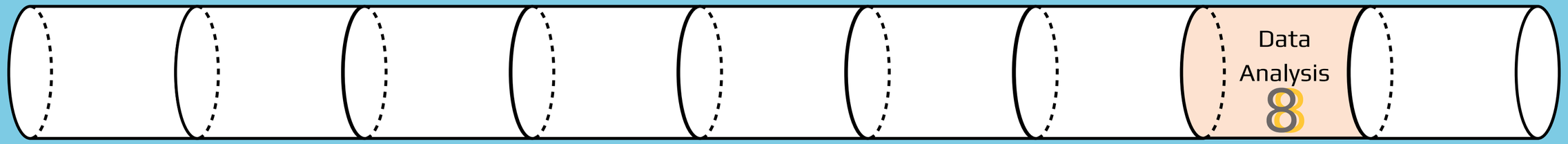
Legend

- stars - t2g5
- dots - t2g2

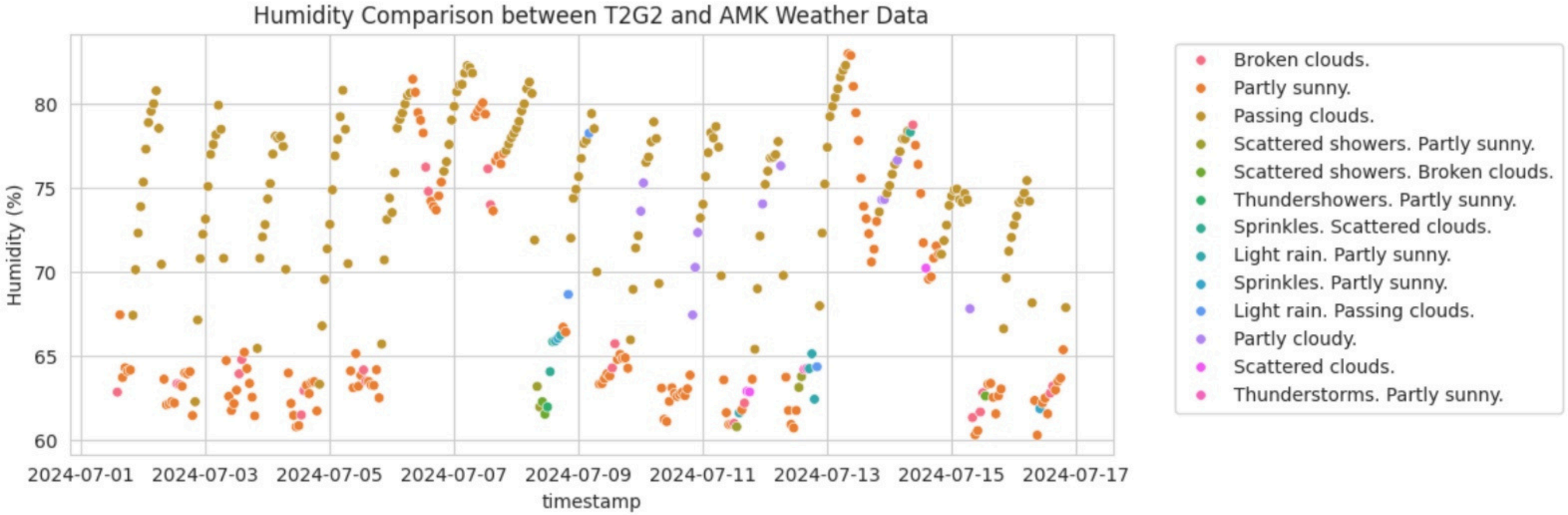


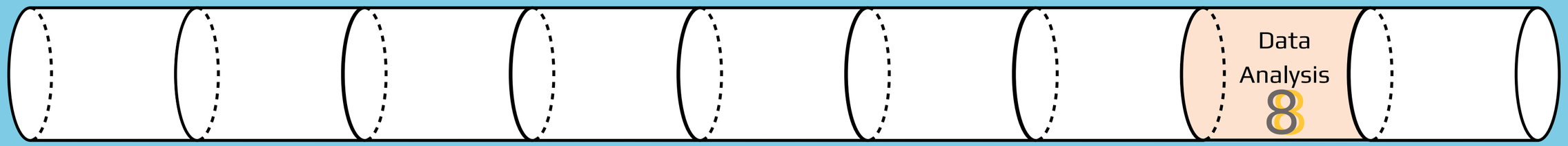
Data analysis ... AMK



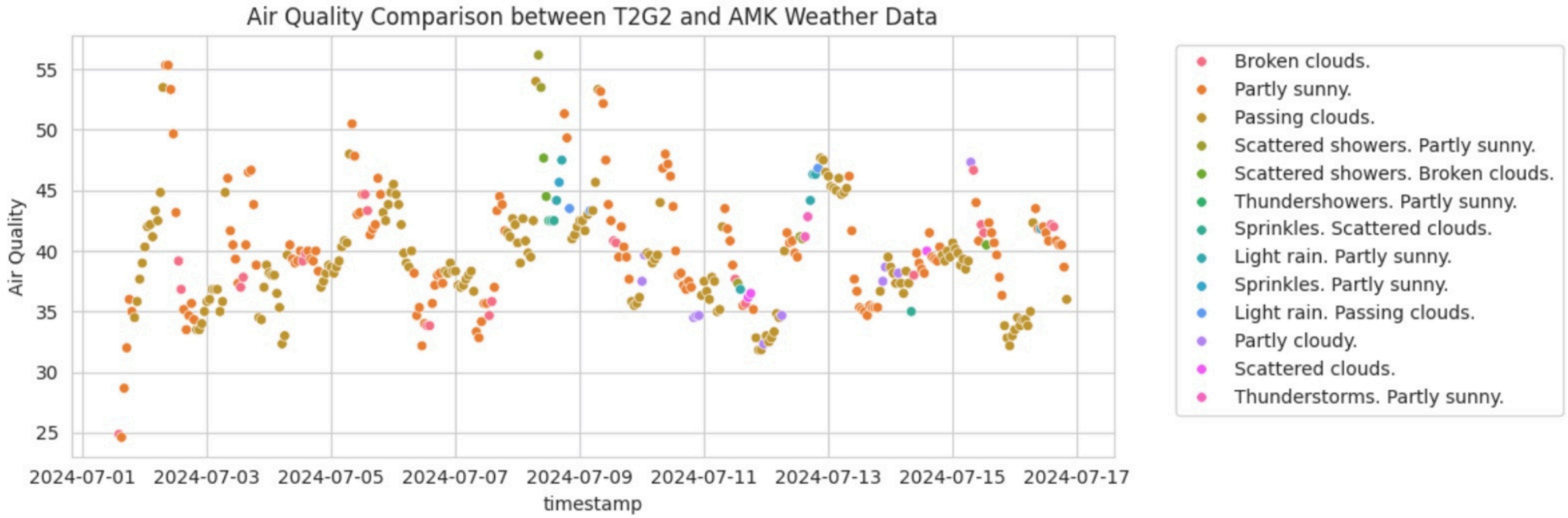


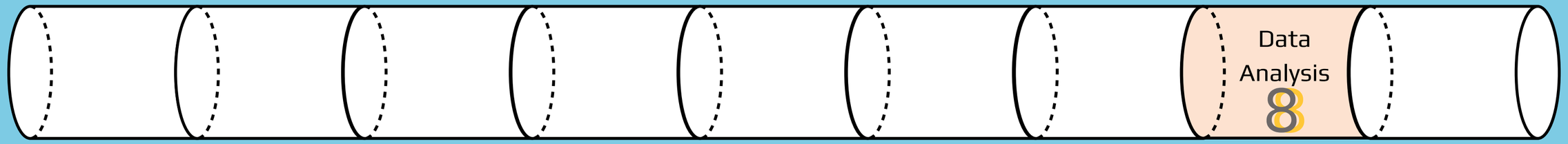
Data analysis ... AMK





Data analysis ... AMK





Results ...

Based on the data:

- Effective Indoor Environmental Control System
- Consistent and Regular Indoor Environment
- Good Isolation against Outdoor External Factors
- Extreme Weather Conditions may sometimes affect indoor environment

Other merits:

- A weekly log book of what went well and what went sour
- A complete data pipeline and resources

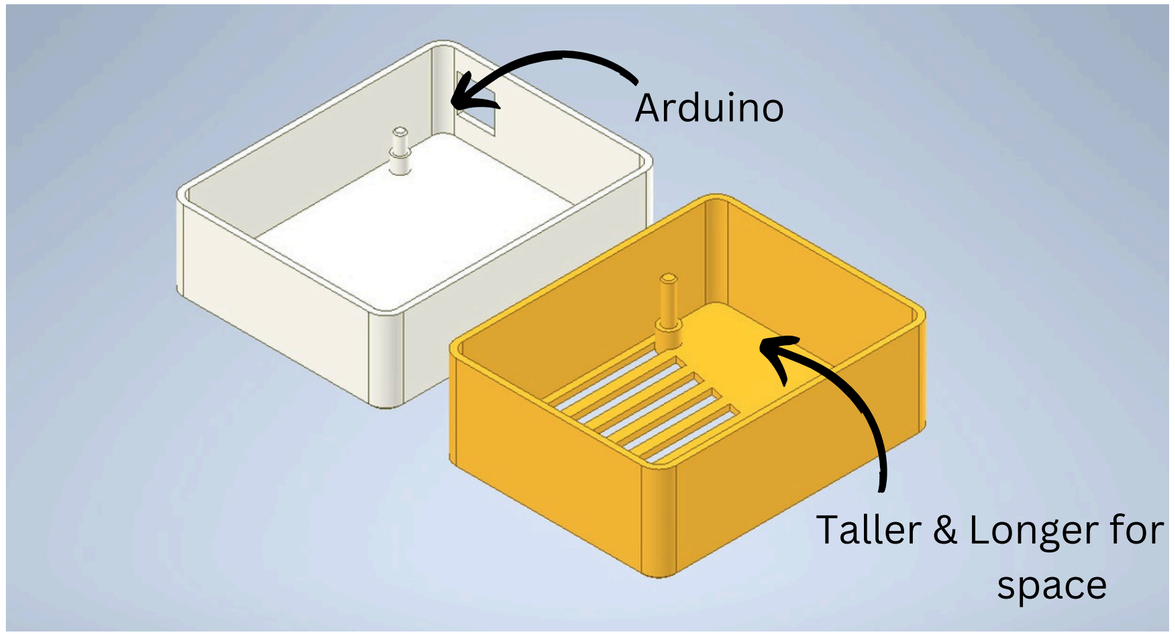
for future sensor data collection and analysis in different settings

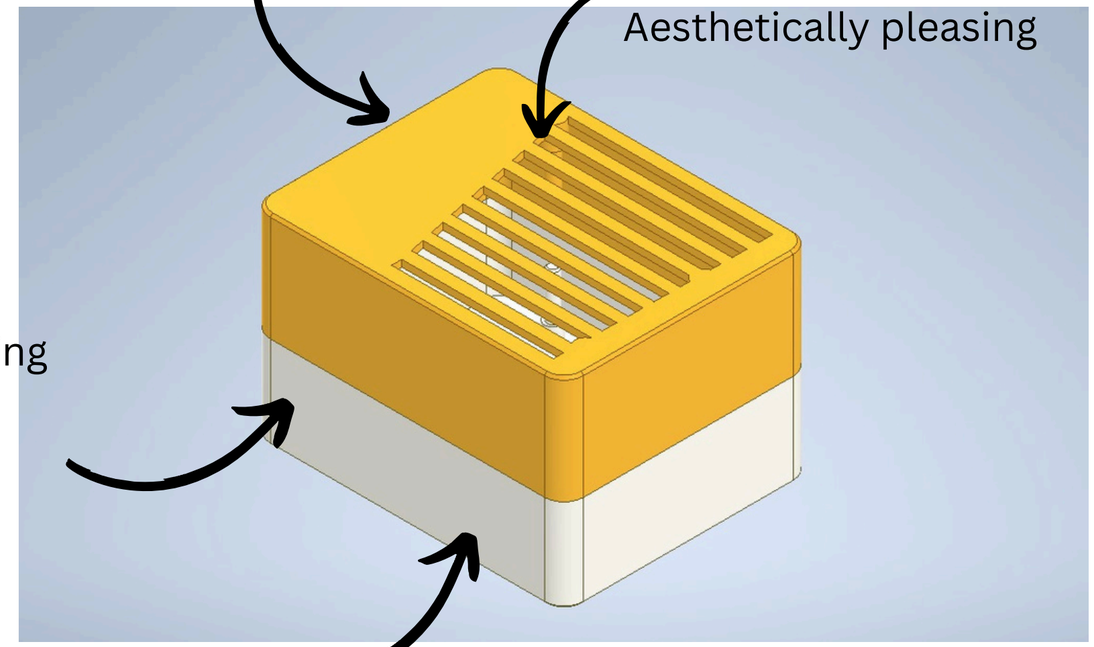
Risk Management ...

Potential risks	Mitigation
Failing sensors	Monitor the data regularly, Prepare backup sensors
Software malfunctioned	Alert & debug ASAP
Wrongly stored data	Check the topic for transmitting and retrieving data, Clean and process the errors if possible
Delayed deadlines	Keep updating the progress in Gantt Chart, Remind each other

Enhancements

Arduino prototype box





Conclusion

- intuitive and iterative way to visualise the conditions of the shop floor to suit a variety of machines
- With the output of our project, users are able to set the climate control of the exact needs of the factory floor. Thus reducing excessive power usage for climate control.

Future improvements

- Usage of better air quality sensor to ensure more accurate and reliable data
- Usage of multiple Arduinos around the factory floor to provide data for more areas around the factory floor.

References

www.timeanddate.com

Q&A