Greenwatch User Manual

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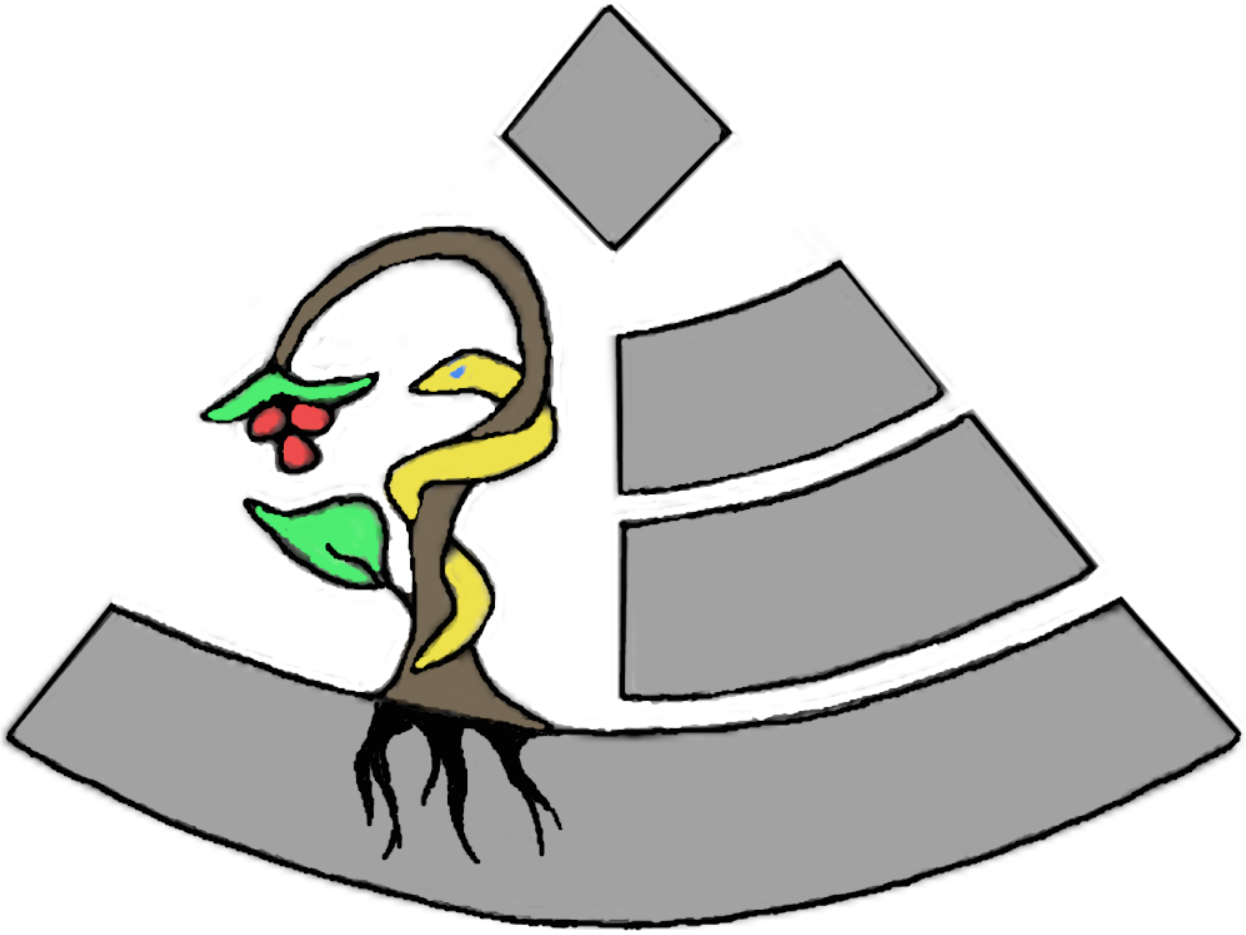

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1. Introduction

1.1) Purpose

The purpose of this software is to provide a method of monitoring and keeping track of the environmental conditions of a greenhouse which includes measuring temperature, humidity, air pressure, and light over a period of time. The system will run on a series of Raspberry Pis with the measurements taken by attached Raspberry Pi Sense HATs and light sensors on the breadboard. The intended client of this project is the Biology department for use in the Midwestern State University greenhouse. Though, through our README file on our Github repo, anybody could get this software working for their own greenhouse given they have the proper hardware. There are hopes to use this project to spiral into others in coordination with the Computer Science department, these could include further iterations on Greenwatch to add various components throughout the greenhouse.

1.2) Users

The intended users of the system are students, professors, and other research staff of the Biology department. The users are designated either admin or non-admin. Admin have the ability to control the configuration of Greenwatch, such as creating rooms, agents, users, experiments, etc. Non-admin will have no rights within the dashboard. They will only be able to view the data that has been recorded for all rooms, experiments, and messages.

1.3 - Accessibility

To access the application the user will simply go to http://40.112.52.52 and login through the login page once an existing admin has created a username/password for the user to access the dashboard. The server currently running Greenwatch can change and all users of the application will be notified of the changes. A bit down the road we plan on proposing a new iteration with more money to fund a better server and a domain name like greenwatch.co or something along those lines.

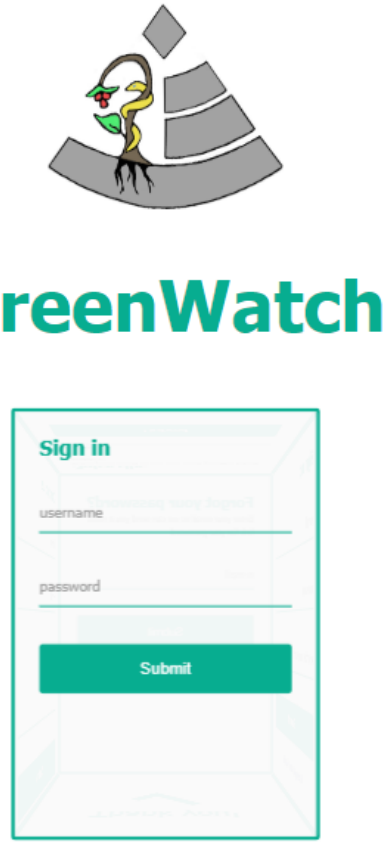
2. System Overview

2.1) Getting Started

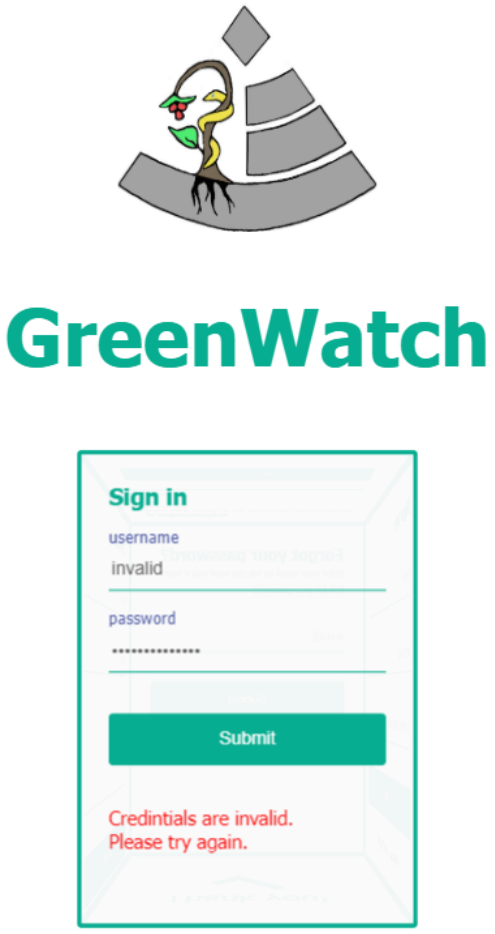
Once the system is functional with a public IP address. All we will need to do is go to that IP address/domain on a public browser and it will redirect you to the login page.

2.2) Login Page

Once a user or admin has arrived at the login screen through a browser they must enter their username and password.

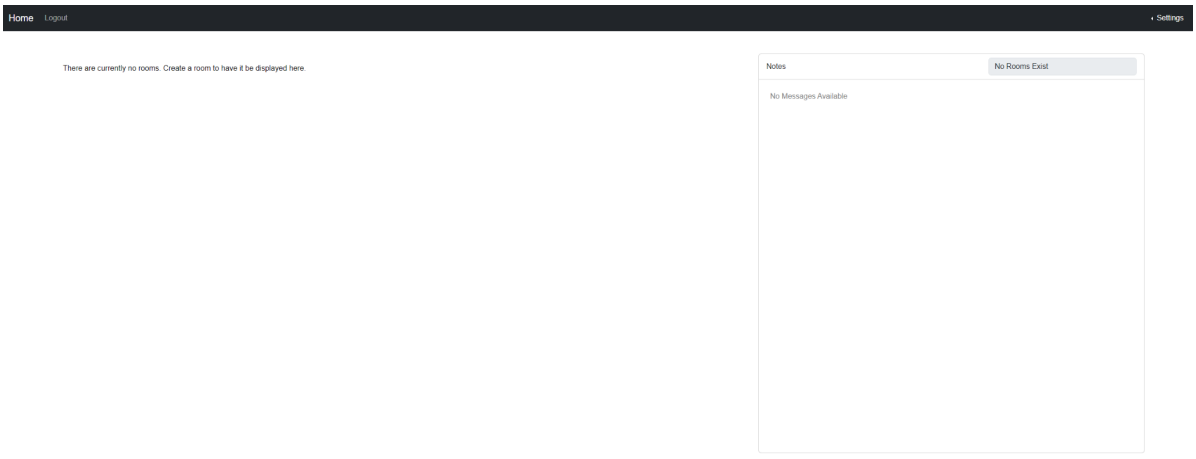


Should the user enter invalid credentials an error message will appear below until valid credentials are used.

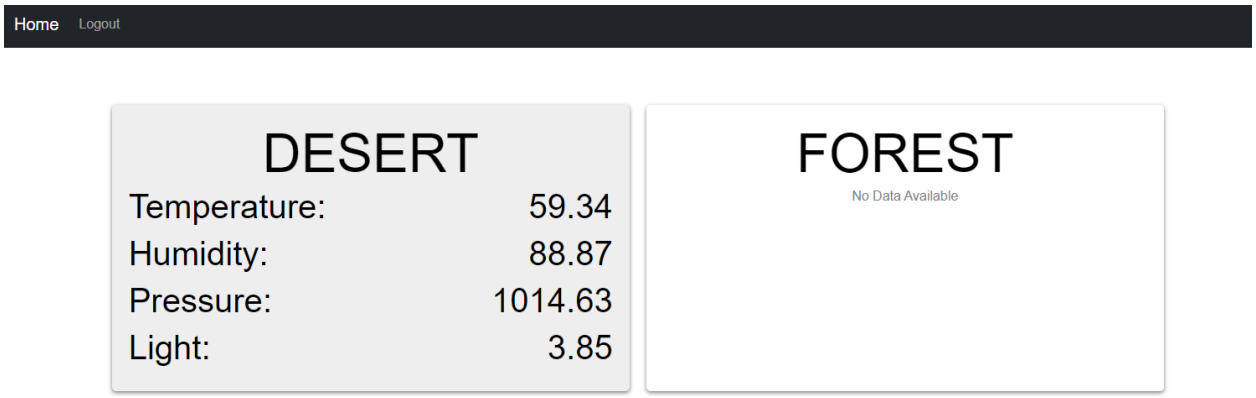


2.3) Rooms Home Page

Once logged in, the user will be brought to the rooms page which will display all rooms within that have been added to the system. Should the system be newly set up, it is very likely to see a sparsely populated page like so:



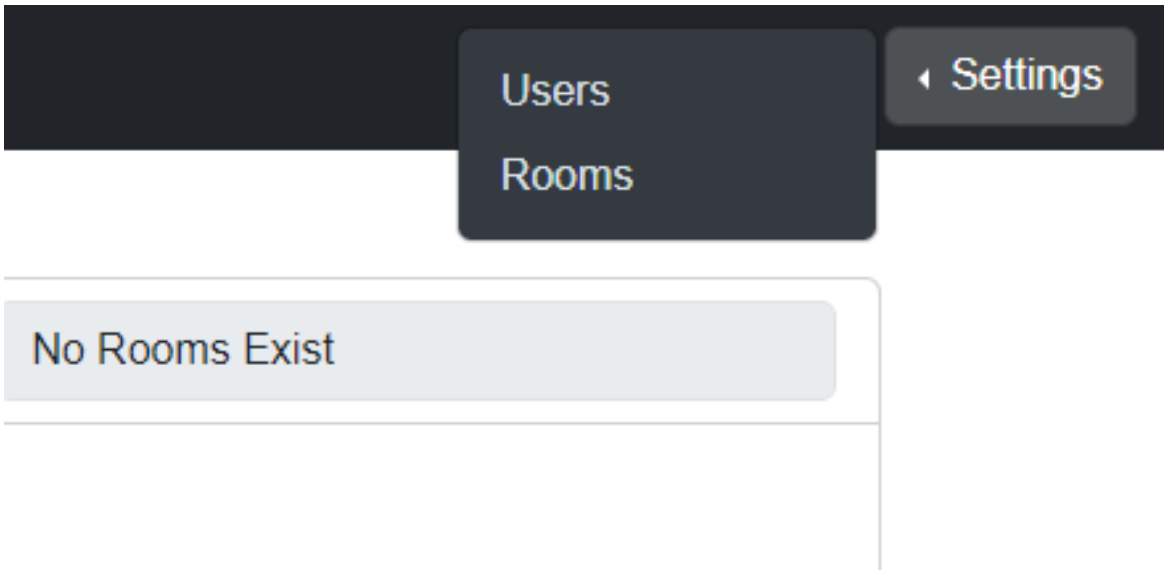
A more developed Home page with rooms containing measurement data may appear like so, displaying 4 relevant environmental conditions per connected room at a glance:



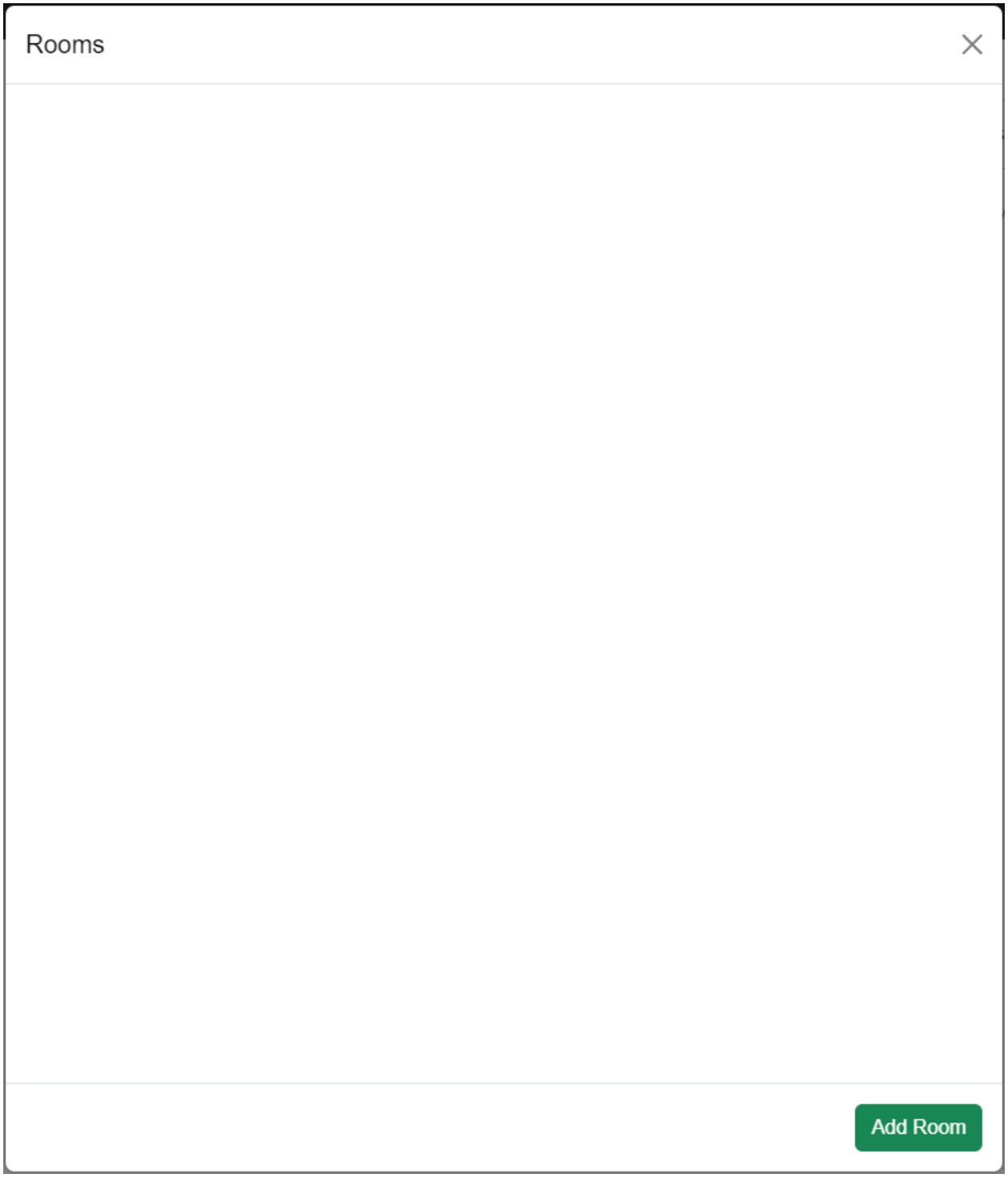
It should be noted that logging out or returning to the Home page is always achievable through pressing their buttons in the top Left corner of the screen.

2.3.1) Adding Rooms (Admin Only)

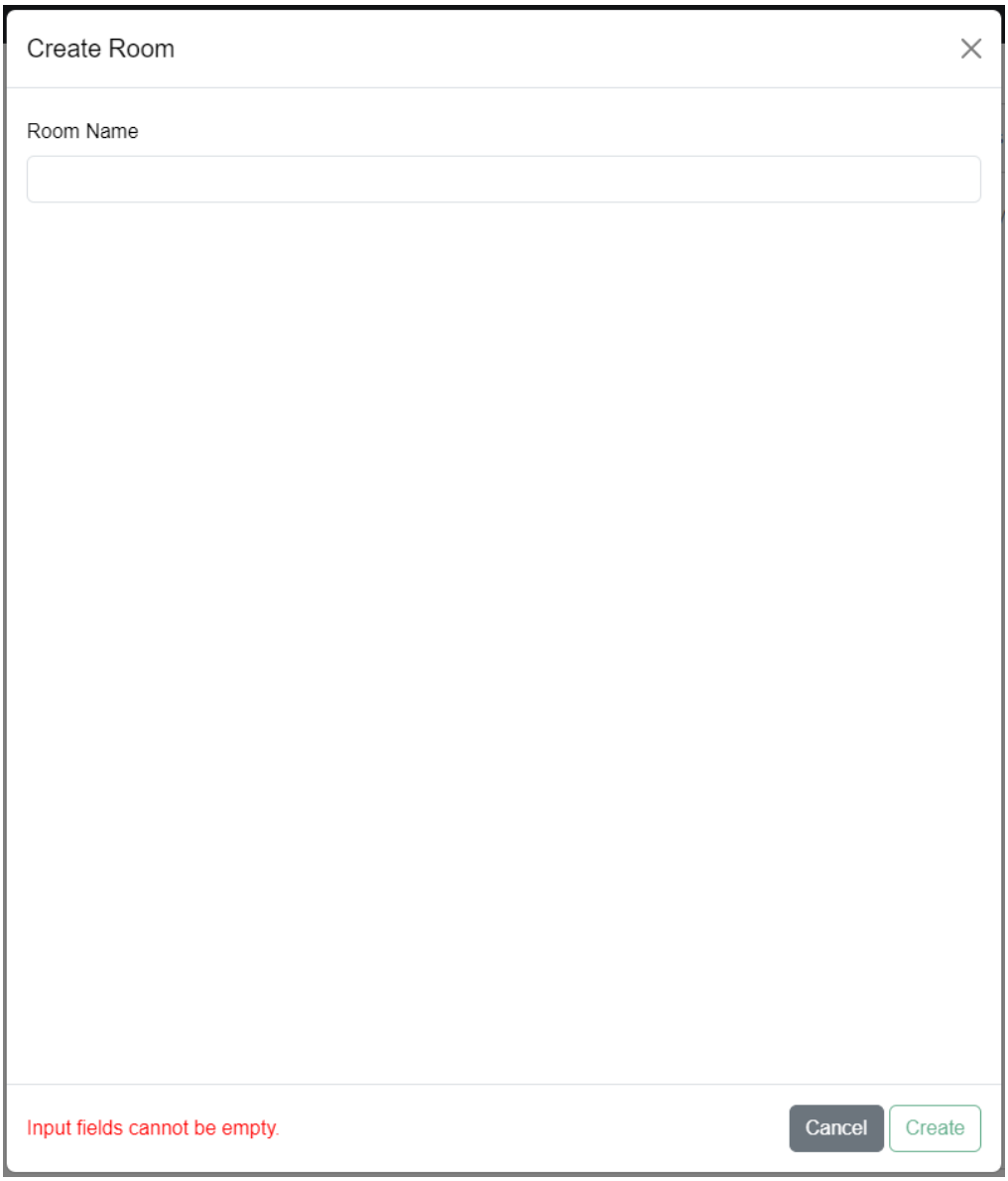
In order to add a room, first click on the settings button on the top right corner of the screen to display a dropdown and select rooms.



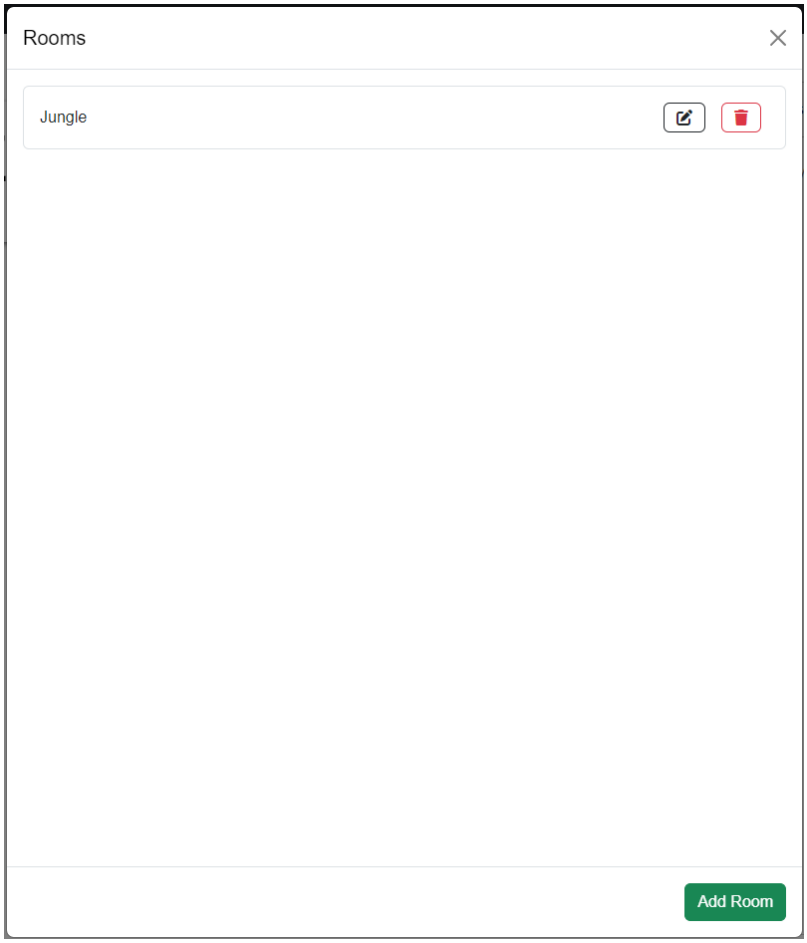
This will bring up the list of Rooms within the system. This list will be empty starting out. In order to create a new room, simply click on the “Add Room” button in the lower right corner of the pop up.



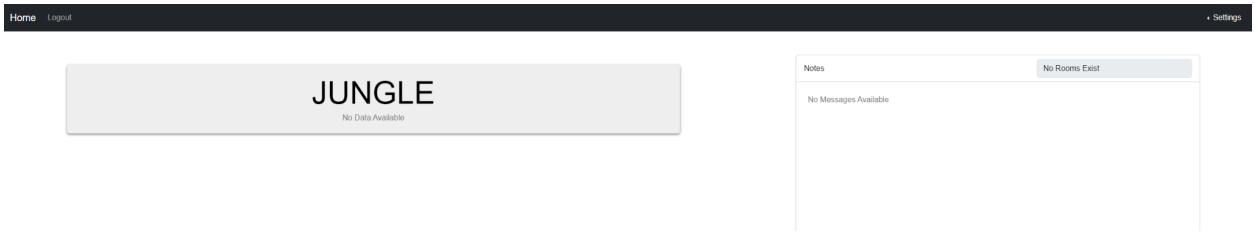
Once clicked, you now may create a room by simply entering what you would like to name it. The system will not accept an empty entry. Once you have the name, simply click create in the lower right hand corner of the pop-up.



Once created, the new room should show in the popup like so:



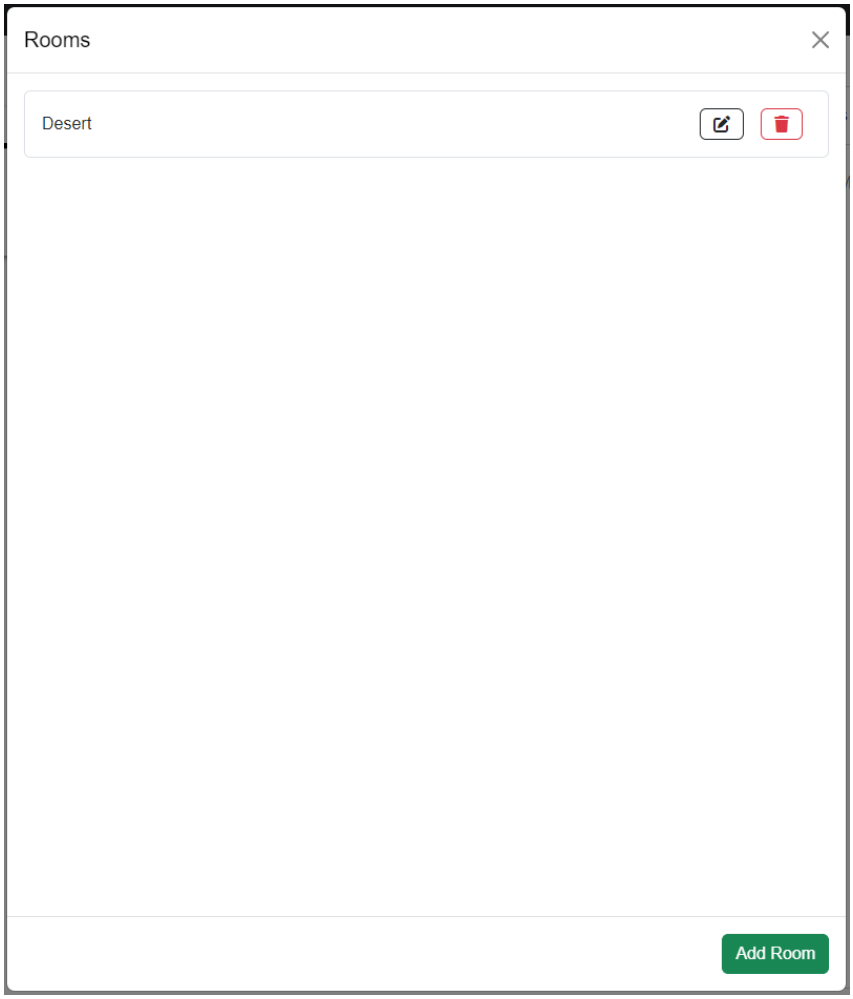
And appear in the Home page like so:



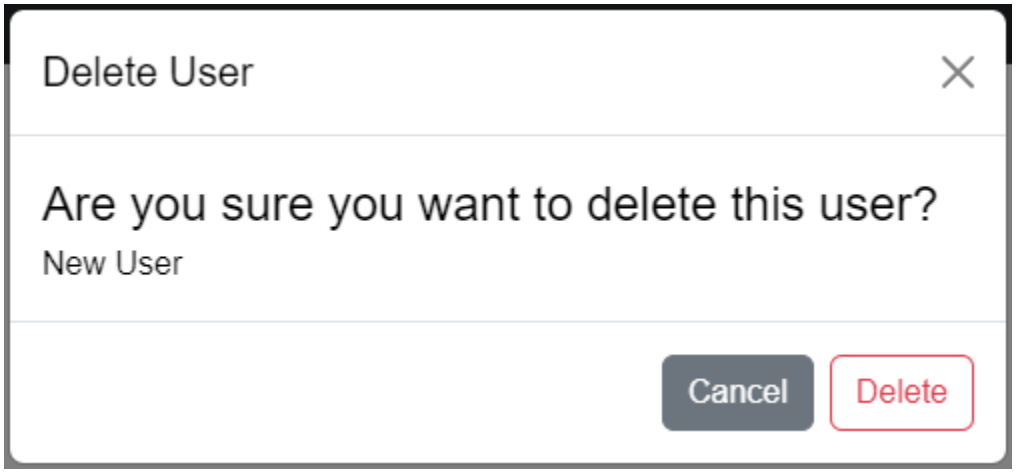
2.3.2) Editing and deleting Rooms (Admin Only)

To edit or delete a room, return to the room list pop-up by clicking on the settings button in the top right corner to bring back the Room list. Here on a room entry are two icons a pen-paper

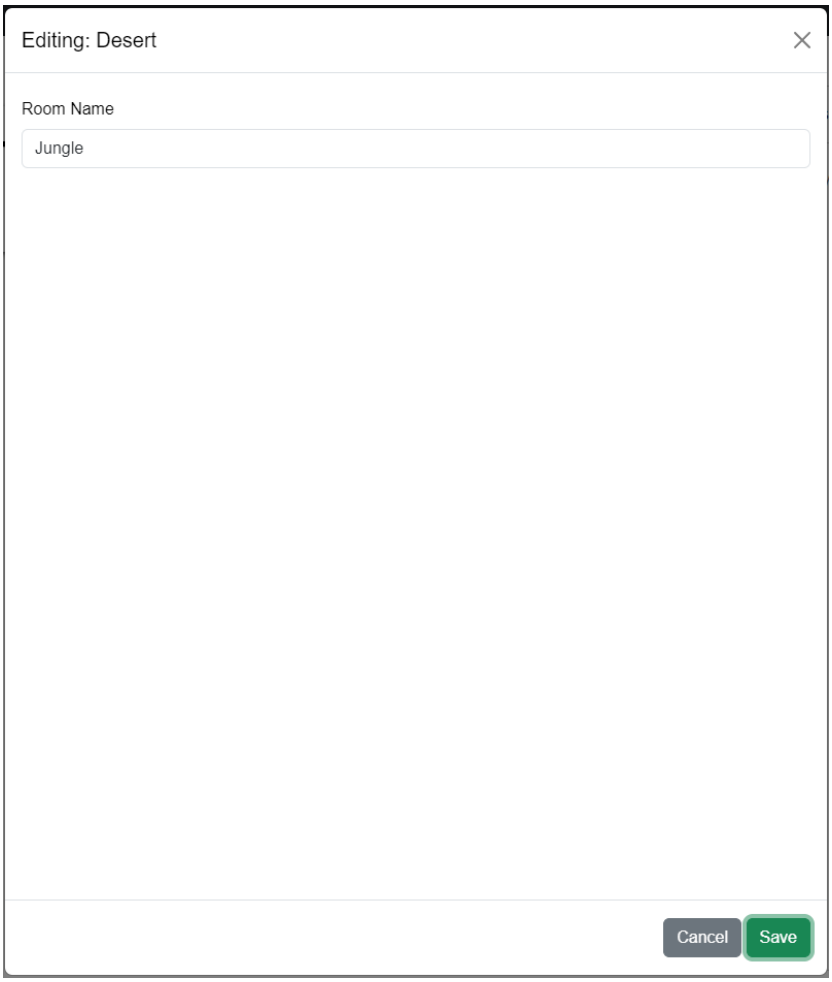
icon and a trashcan icon which represent editing and deleting the room page respectively.



Clicking on the delete button will prompt the user with another pop-up that will ask the user to confirm deletion of the room. Click on the delete button to confirm room deletion.

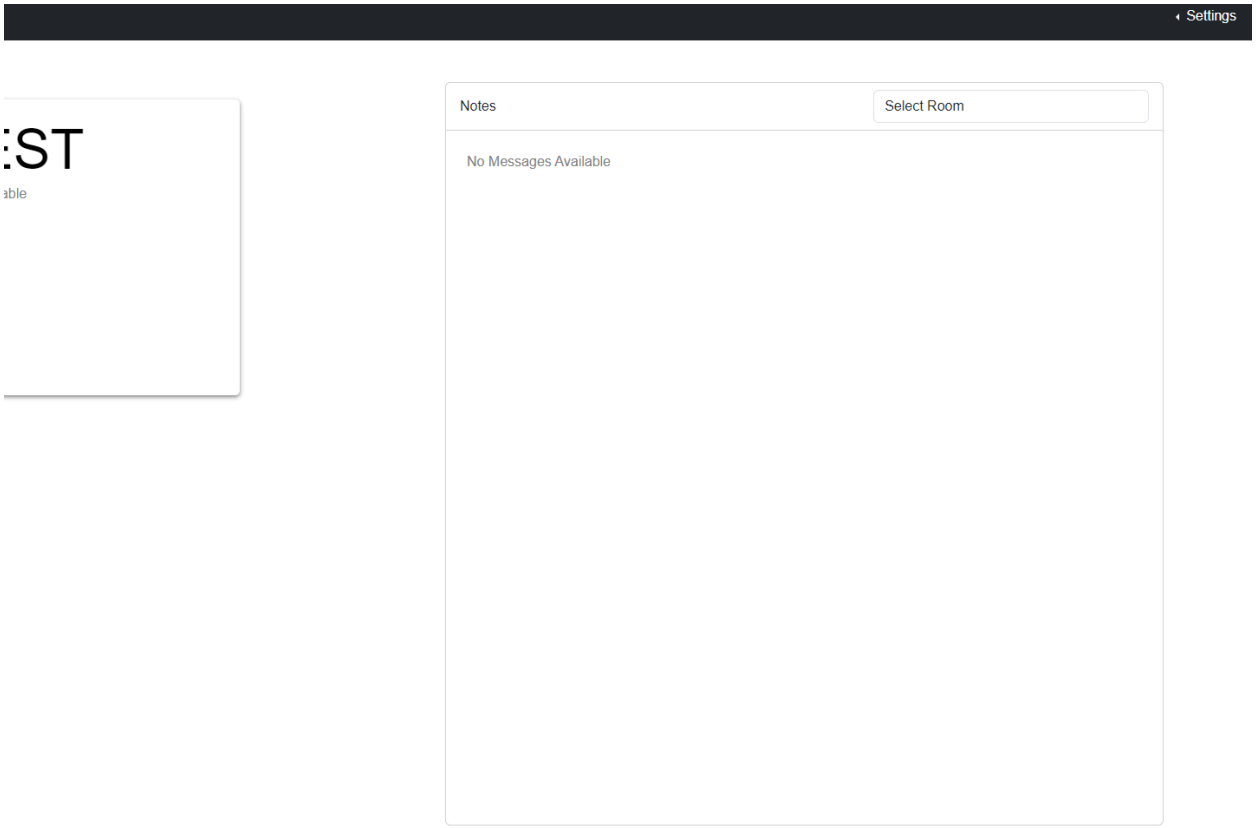


Should the user elect to instead click on the pen-paper edit button on the room list page, it will bring up a popup that allows the user to edit the room name. Once the name has been changed, simply click the “Save” button in the lower right hand corner of the popup to save the changes.

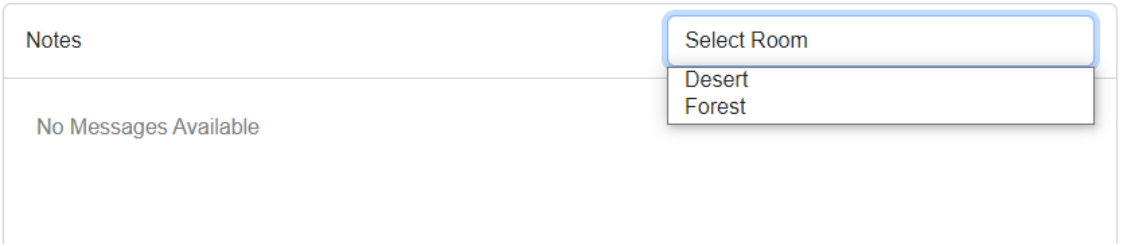


2.3.3) Notes Overview

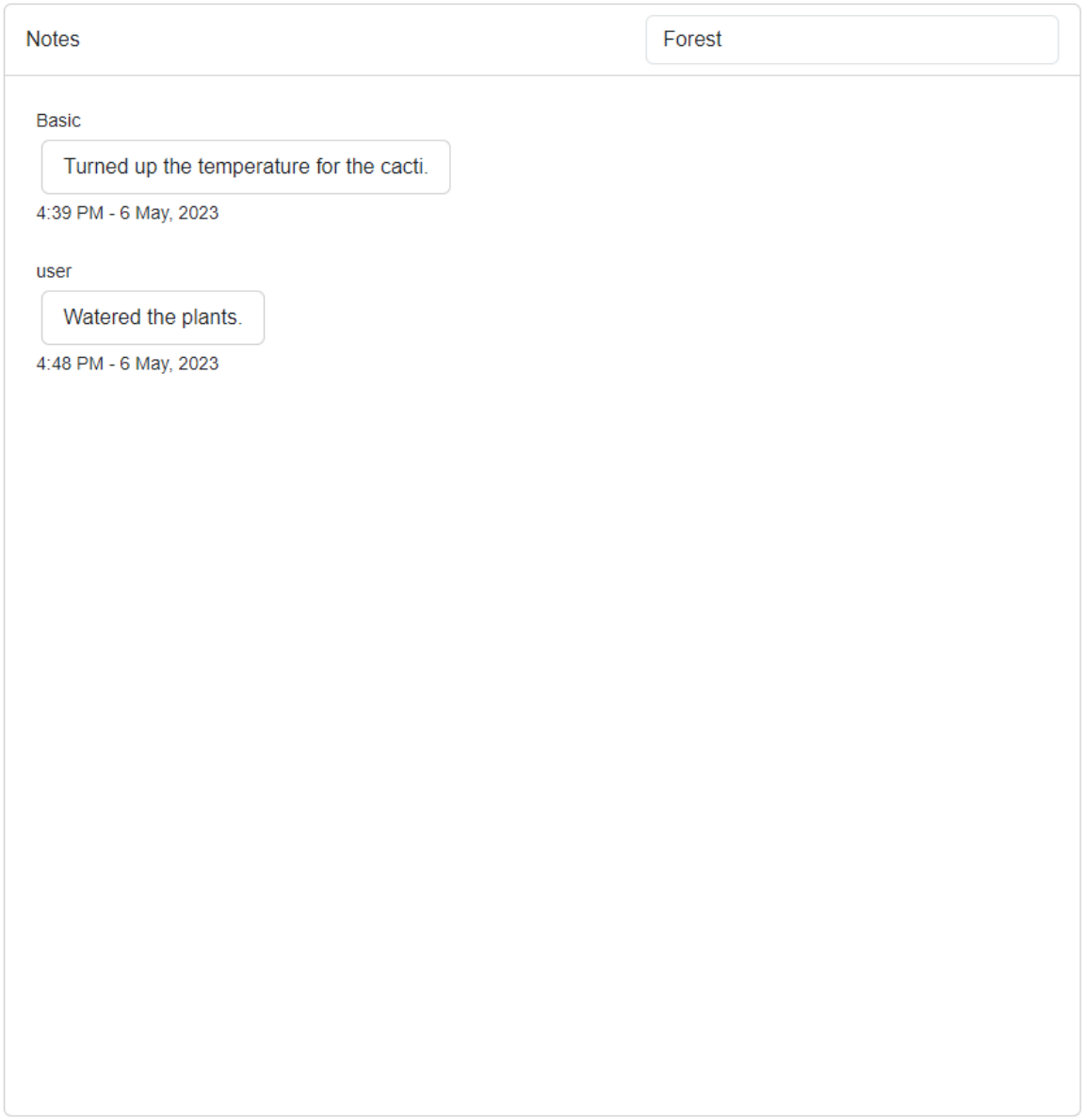
On the Homepage, on the right hand half of the screen, there is a notes section that will display the written user notes of a selected room.



Simply select a room from the notes section's "Select Room" drop down to check the intended room's notes.

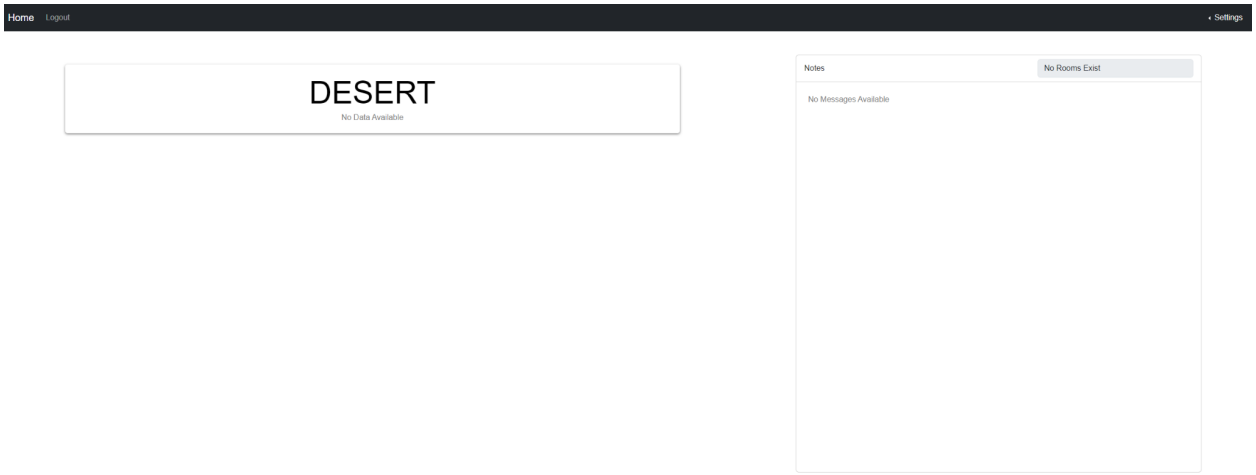


And the selected room's notes will be displayed. It is important to note that a user or admin cannot add new notes from here, only view them.

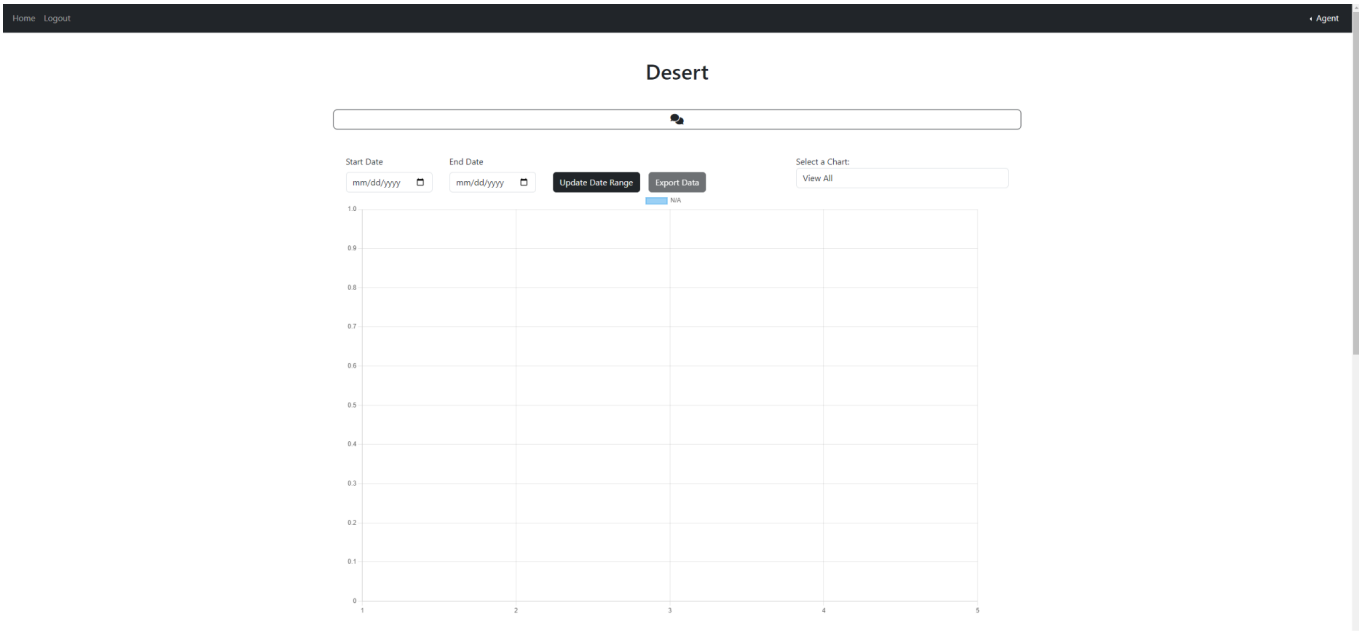


2.4) Room Page

To have an in depth look of the data over time, and access the agents that handle the measurements, simply click on a room itself to take you to its room page.

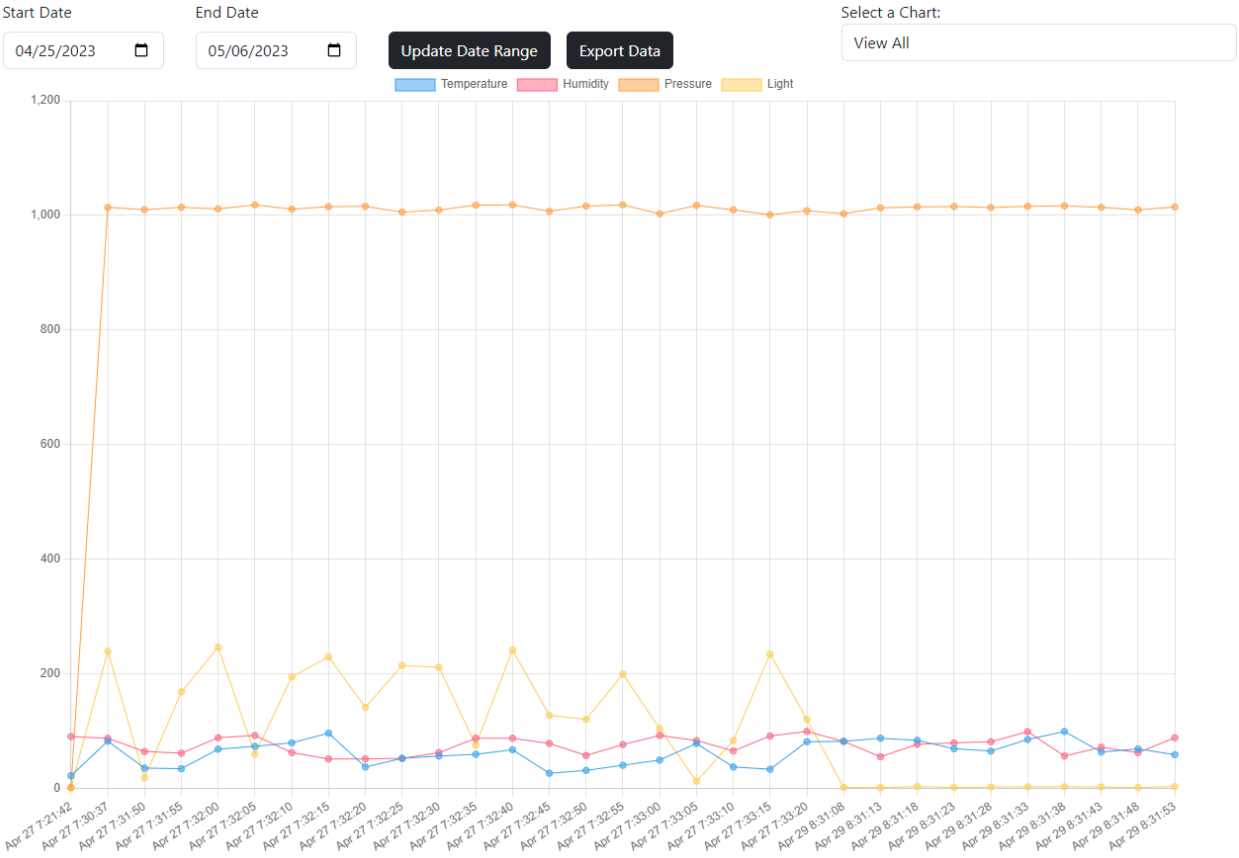


Once selected, the Room page will display like so:

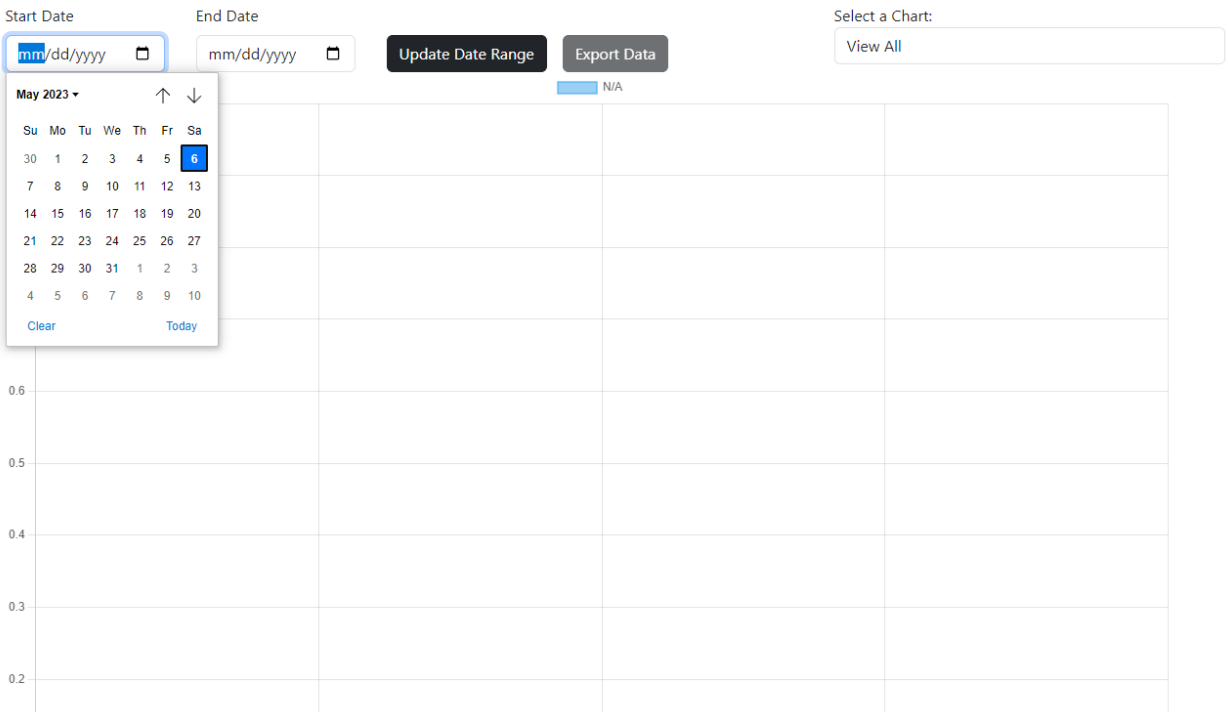


2.5) Charts and Exporting Data

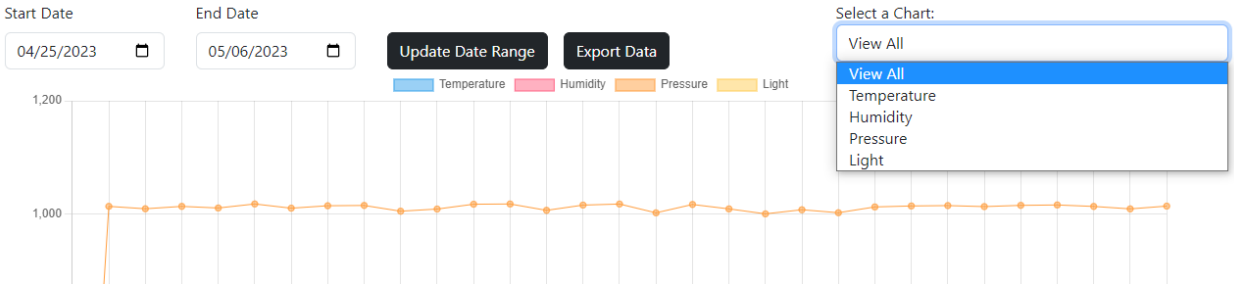
At the center of the page, if there is a connected agent, there should be a display of relevant data of Temperature, Humidity, Pressure, and Light over a course of time frame:



A user may decide to determine the start and end date of the graph by selecting the appropriate dates to the top left of the graph. Once a range is selected, simply click on the “Update Date Range” button to display the new graph.

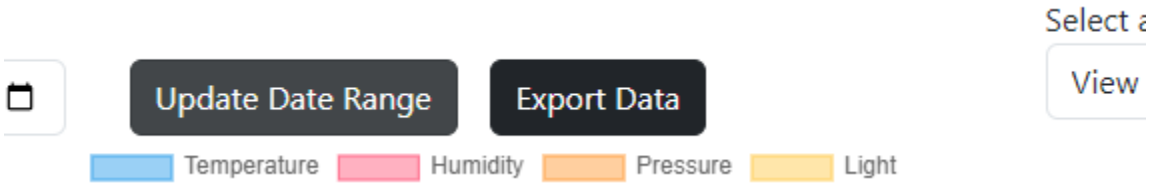


To the Top right, there is a dropdown where a user may decide which of the 4 measurements should be displayed or view them all at once. By default, all measurements should display.

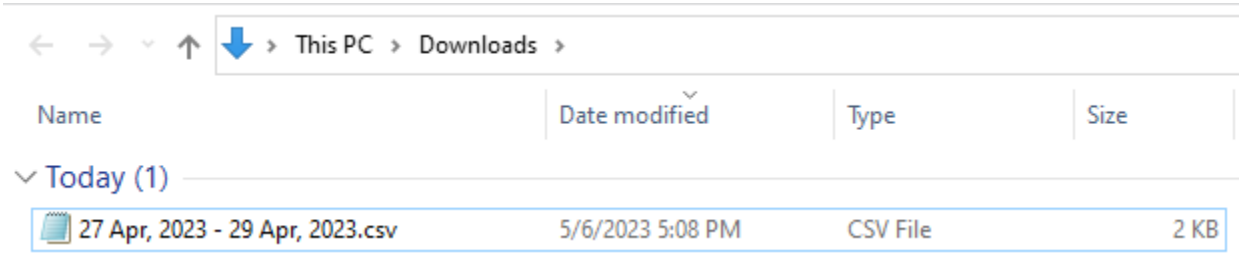


2.5.1) Exporting data

Should a user wish to export the data to an excel spreadsheet or google spreadsheet, simply select what the environmental conditions and range you wish to view and then click on the “Export Data” button to create a .csv file that can be opened in a spreadsheet application.



How a .csv file appears once downloaded:



How a .csv file when opened in a notepad application:

27 Apr, 2023 - 29 Apr, 2023.csv - Notepad

File Edit Format View Help

```
humidity,light,pressure,temperature,timestamp
91,1.3,2.34,22.6,"Thu, 27 Apr 2023 19:21:42 GMT"
88,240,1014.17,83,"Thu, 27 Apr 2023 19:30:37 GMT"
65,19,1009.95,36,"Thu, 27 Apr 2023 19:31:50 GMT"
62,169,1014.13,35,"Thu, 27 Apr 2023 19:31:55 GMT"
89,247,1011.32,69,"Thu, 27 Apr 2023 19:32:00 GMT"
93,60,1018.41,74,"Thu, 27 Apr 2023 19:32:05 GMT"
63,195,1010.96,80,"Thu, 27 Apr 2023 19:32:10 GMT"
52,230,1015.26,97,"Thu, 27 Apr 2023 19:32:15 GMT"
52,142,1015.76,38,"Thu, 27 Apr 2023 19:32:20 GMT"
53,215,1005.65,53,"Thu, 27 Apr 2023 19:32:25 GMT"
63,212,1009.46,57,"Thu, 27 Apr 2023 19:32:30 GMT"
88,76,1017.95,60,"Thu, 27 Apr 2023 19:32:35 GMT"
88,242,1018.35,68,"Thu, 27 Apr 2023 19:32:40 GMT"
79,128,1007.16,27,"Thu, 27 Apr 2023 19:32:45 GMT"
58,121,1016.42,32,"Thu, 27 Apr 2023 19:32:50 GMT"
77,200,1018.28,41,"Thu, 27 Apr 2023 19:32:55 GMT"
93,105,1002.8,50,"Thu, 27 Apr 2023 19:33:00 GMT"
84,13,1017.5,79,"Thu, 27 Apr 2023 19:33:05 GMT"
66,84,1009.73,38,"Thu, 27 Apr 2023 19:33:10 GMT"
92,235,1000.99,34,"Thu, 27 Apr 2023 19:33:15 GMT"
100,121,1008.22,82,"Thu, 27 Apr 2023 19:33:20 GMT"
82.53,2.25,1002.97,82.64,"Sat, 29 Apr 2023 20:31:08 GMT"
55.73,1.94,1013.17,88.08,"Sat, 29 Apr 2023 20:31:13 GMT"
77.48,3.7,1014.88,84.41,"Sat, 29 Apr 2023 20:31:18 GMT"
79.99,2.25,1015.53,69.77,"Sat, 29 Apr 2023 20:31:23 GMT"
81.97,2.9,1013.77,65.72,"Sat, 29 Apr 2023 20:31:28 GMT"
99.53,3.39,1015.94,85.84,"Sat, 29 Apr 2023 20:31:33 GMT"
57.08,3.45,1016.65,99.89,"Sat, 29 Apr 2023 20:31:38 GMT"
72.4,3.13,1014.05,63.97,"Sat, 29 Apr 2023 20:31:43 GMT"
62.97,2.09,1009.75,69.55,"Sat, 29 Apr 2023 20:31:48 GMT"
88.87,3.85,1014.63,59.34,"Sat, 29 Apr 2023 20:31:53 GMT"
```

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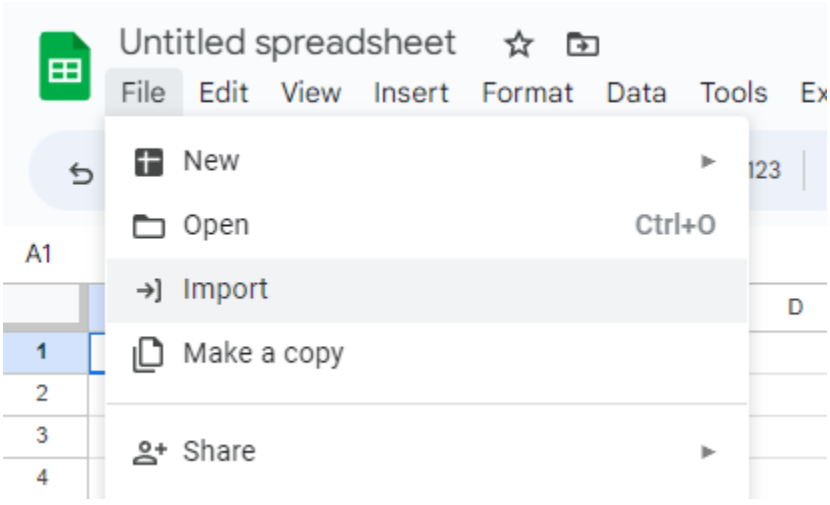
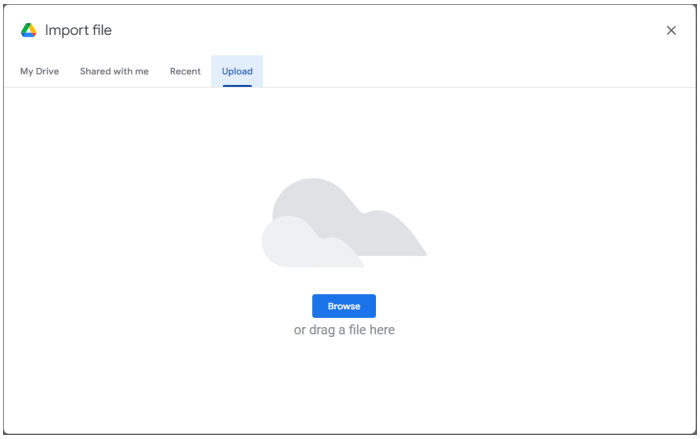
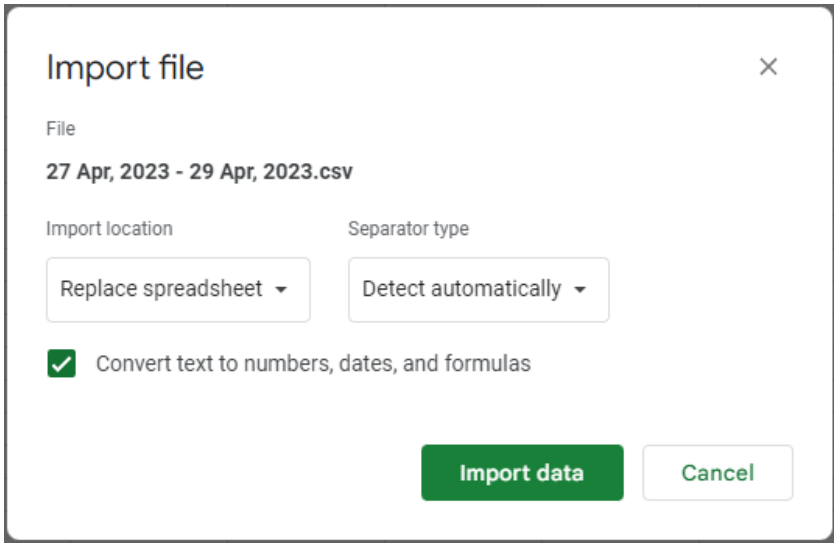
If you wish to view the .csv file in your spreadsheet application simply select the import option on your spreadsheet application.



Browse your computer to where you downloaded the .csv file and select it



And once you start importing the .csv file, set the separator type to “Detect automatically” and check the “Convert text to numbers, dates, and formulas” box then select finally click on “Import Data”.



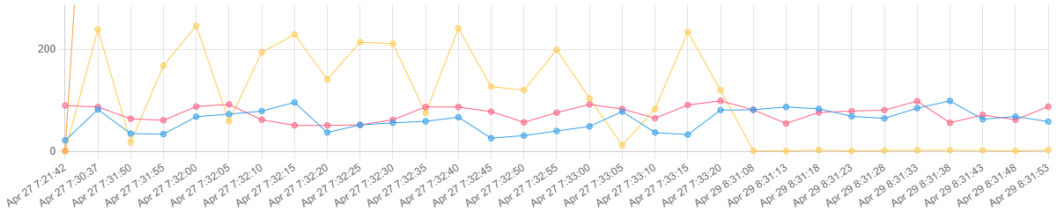
Your spreadsheet should display as so:

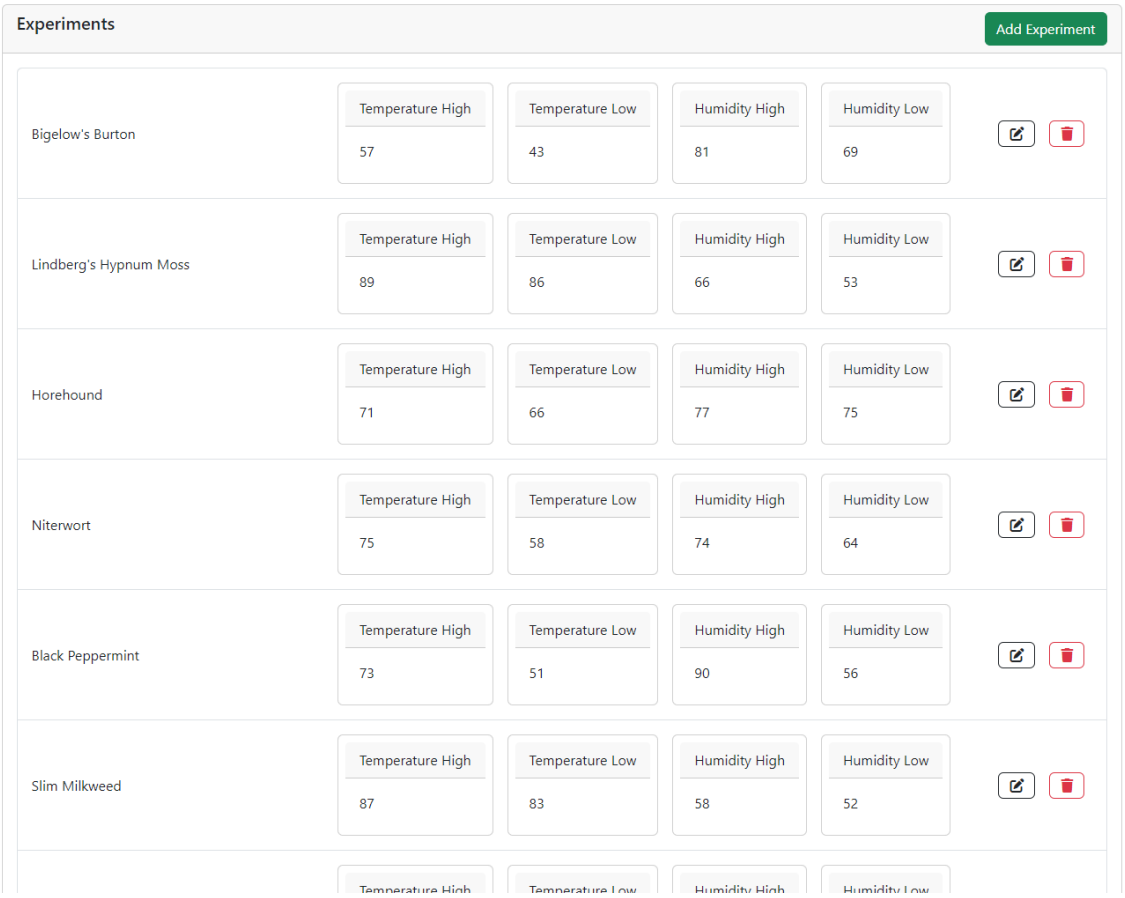
A1 | humidity

	A	B	C	D	E	F	G
1	humidity	light	pressure	temperature	timestamp		
2	91	1.3	2.34	22.6	Thu, 27 Apr 2023 19:21:42 GMT		
3	88	240	1014.17	83	Thu, 27 Apr 2023 19:30:37 GMT		
4	65	19	1009.95	36	Thu, 27 Apr 2023 19:31:50 GMT		
5	62	169	1014.13	35	Thu, 27 Apr 2023 19:31:55 GMT		
6	89	247	1011.32	69	Thu, 27 Apr 2023 19:32:00 GMT		
7	93	60	1018.41	74	Thu, 27 Apr 2023 19:32:05 GMT		
8	63	195	1010.96	80	Thu, 27 Apr 2023 19:32:10 GMT		
9	52	230	1015.26	97	Thu, 27 Apr 2023 19:32:15 GMT		
10	52	142	1015.76	38	Thu, 27 Apr 2023 19:32:20 GMT		
11	53	215	1005.65	53	Thu, 27 Apr 2023 19:32:25 GMT		
12	63	212	1009.46	57	Thu, 27 Apr 2023 19:32:30 GMT		
13	88	76	1017.95	60	Thu, 27 Apr 2023 19:32:35 GMT		
14	88	242	1018.35	68	Thu, 27 Apr 2023 19:32:40 GMT		
15	79	128	1007.16	27	Thu, 27 Apr 2023 19:32:45 GMT		
16	58	121	1016.42	32	Thu, 27 Apr 2023 19:32:50 GMT		
17	77	200	1018.28	41	Thu, 27 Apr 2023 19:32:55 GMT		
18	93	105	1002.8	50	Thu, 27 Apr 2023 19:33:00 GMT		
19	84	13	1017.5	79	Thu, 27 Apr 2023 19:33:05 GMT		
20	66	84	1009.73	38	Thu, 27 Apr 2023 19:33:10 GMT		
21	92	235	1000.99	34	Thu, 27 Apr 2023 19:33:15 GMT		
22	100	121	1008.22	82	Thu, 27 Apr 2023 19:33:20 GMT		
23	82.53	2.25	1002.97	82.64	Sat, 29 Apr 2023 20:31:08 GMT		
24	55.73	1.94	1013.17	88.08	Sat, 29 Apr 2023 20:31:13 GMT		
25	77.48	3.7	1014.88	84.41	Sat, 29 Apr 2023 20:31:18 GMT		
26	79.99	2.25	1015.53	69.77	Sat, 29 Apr 2023 20:31:23 GMT		
27	81.97	2.9	1013.77	65.72	Sat, 29 Apr 2023 20:31:28 GMT		
28	99.53	3.39	1015.94	85.84	Sat, 29 Apr 2023 20:31:33 GMT		
29	57.08	3.45	1016.65	99.89	Sat, 29 Apr 2023 20:31:38 GMT		
30	72.4	3.13	1014.05	63.97	Sat, 29 Apr 2023 20:31:43 GMT		
31	62.97	2.09	1009.75	69.55	Sat, 29 Apr 2023 20:31:48 GMT		
32	88.87	3.85	1014.63	59.34	Sat, 29 Apr 2023 20:31:53 GMT		
33							
34							
35							

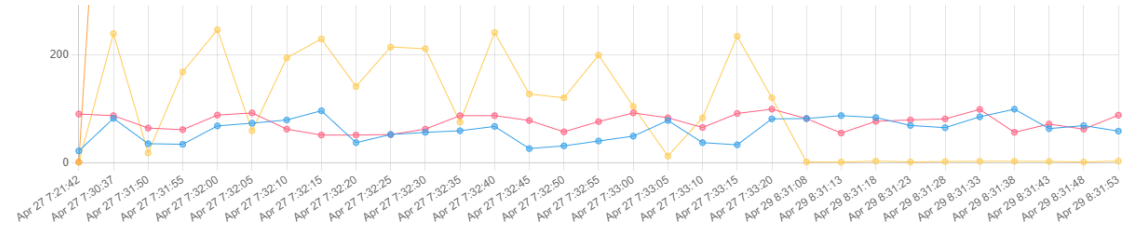
2.6) Experiments

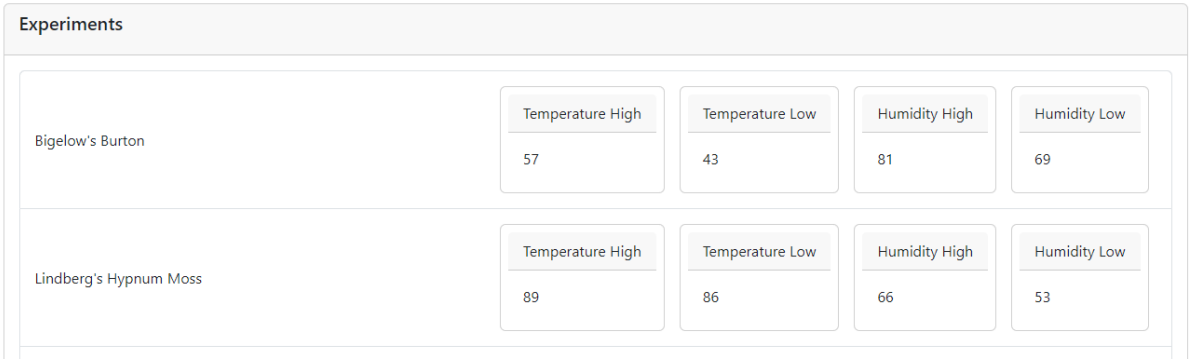
Underneath the graph of the Room Page, there is a section dedicated to experiments. Here different experiments with their own lows/highs for temperature and humidity are displayed at a glance. It should be noted this section appears different depending on privileges of the user depending on if they are an Admin account or not. An admin account will have the added option to add experiments, edit experiments, and delete them as represented by their respective buttons as shown below.



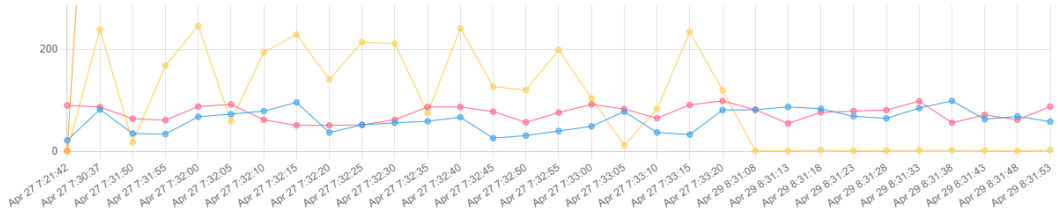


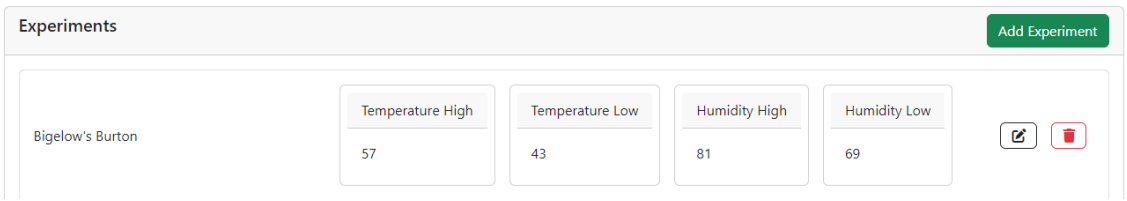
Here is how the experiments section appears to a non-admin user account:



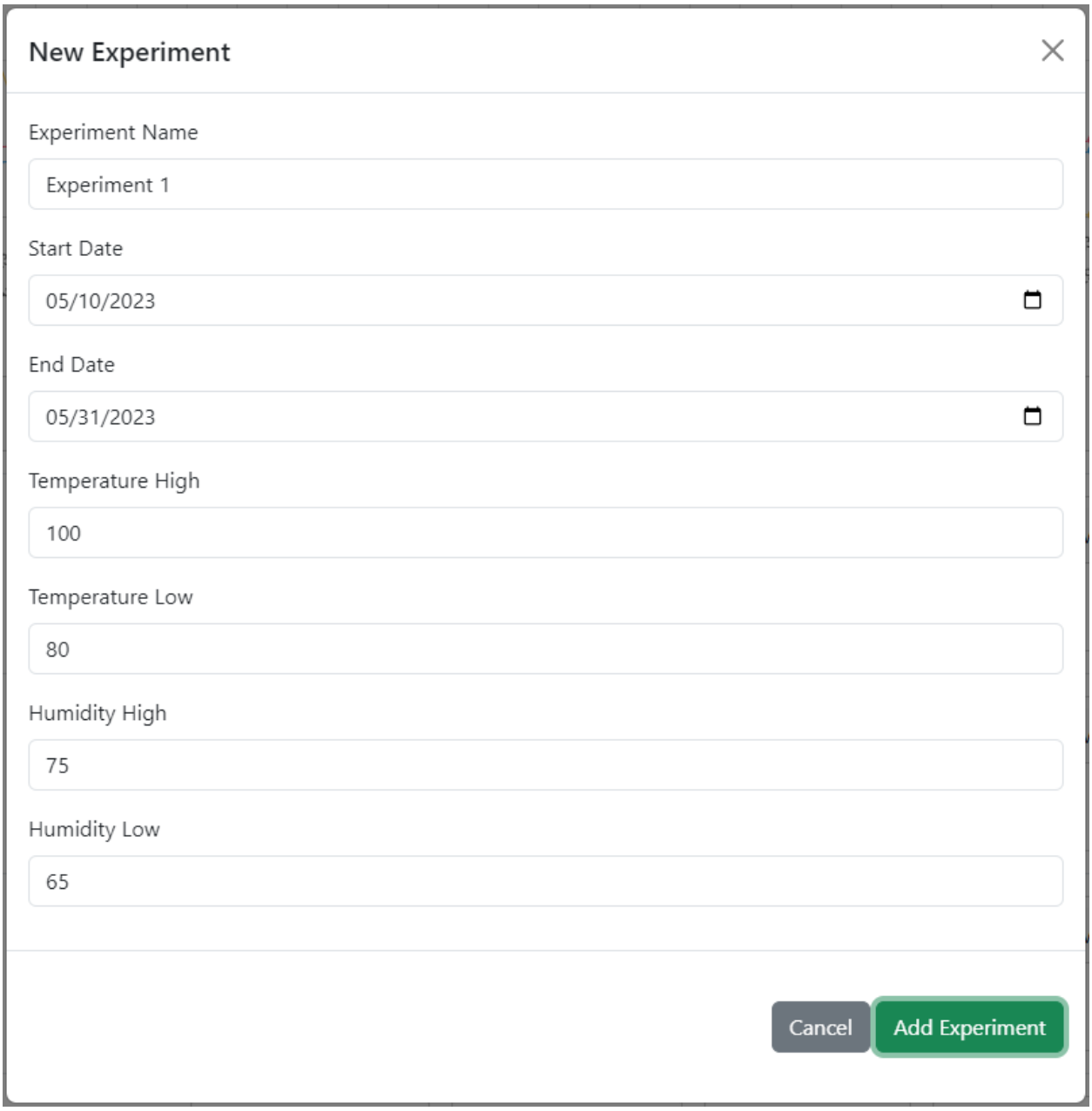


To create an experiment, an admin must click on a the add experiment button on the top right corner of the experiments section (This button will not appear for non-admin users)

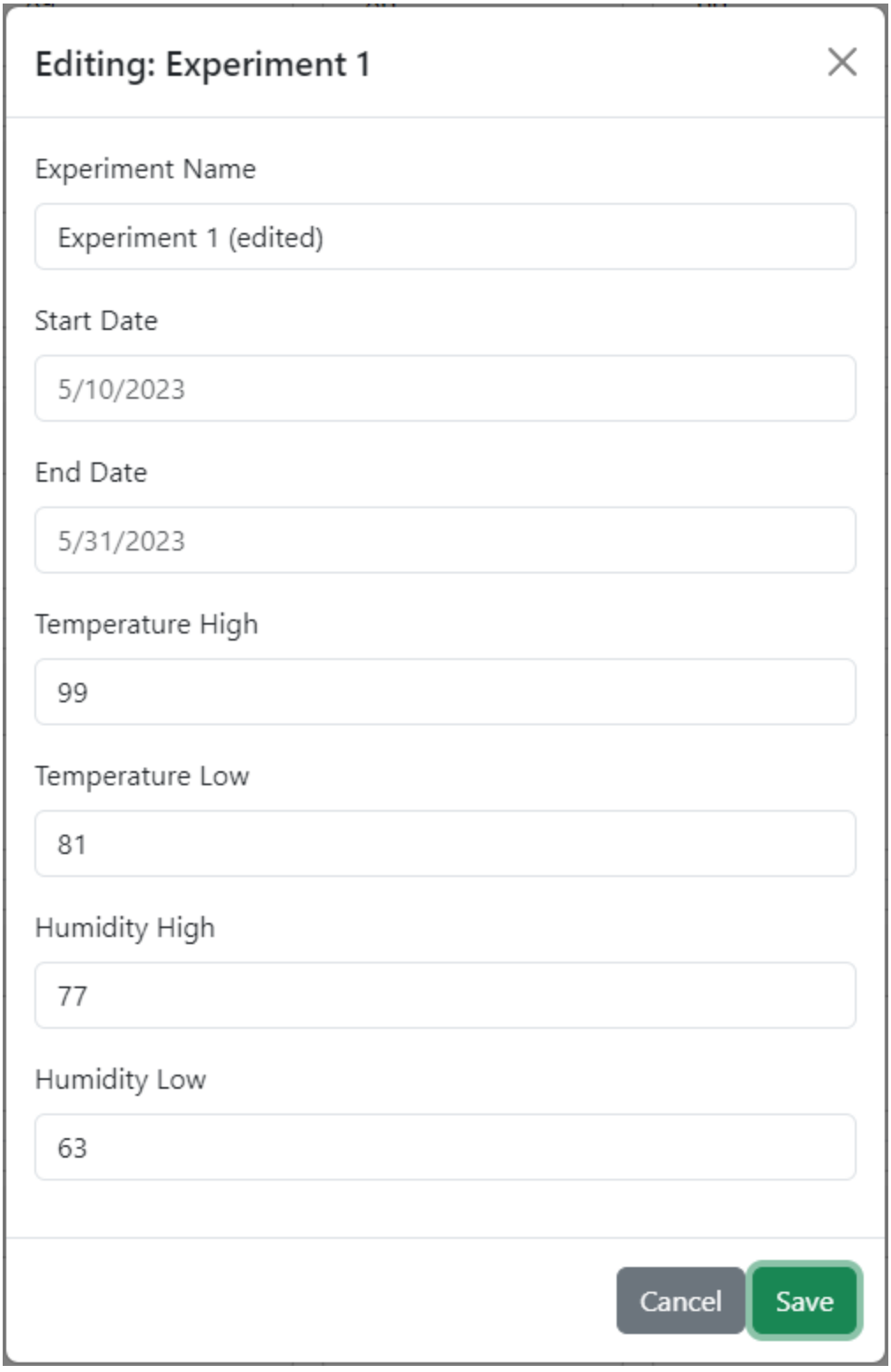




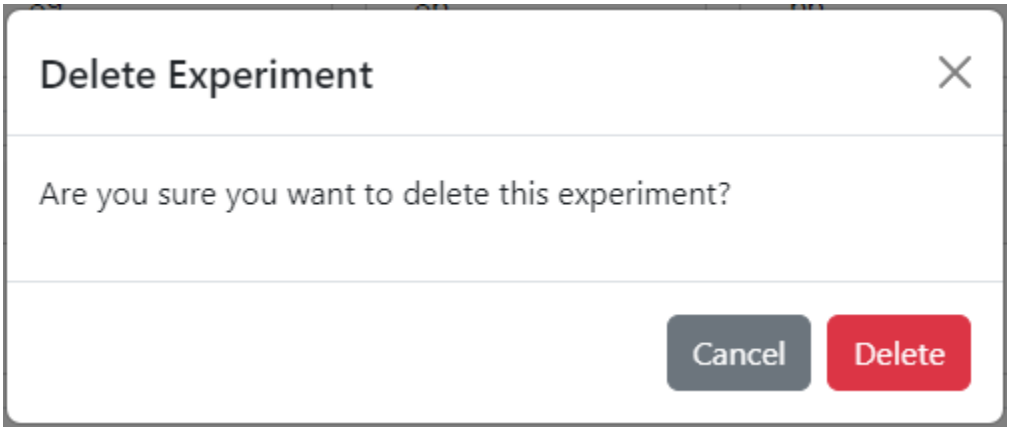
This will bring up a new pop-up with fields that allow the user to create an experiment under their specifications. Click on “Add Experiments” to finalize it.



Should an Admin wish to edit an experiment, they simply need to click on the pen-paper icon of the experiment section of the room page. To bring up the edit dropdown and click save to confirm changes.



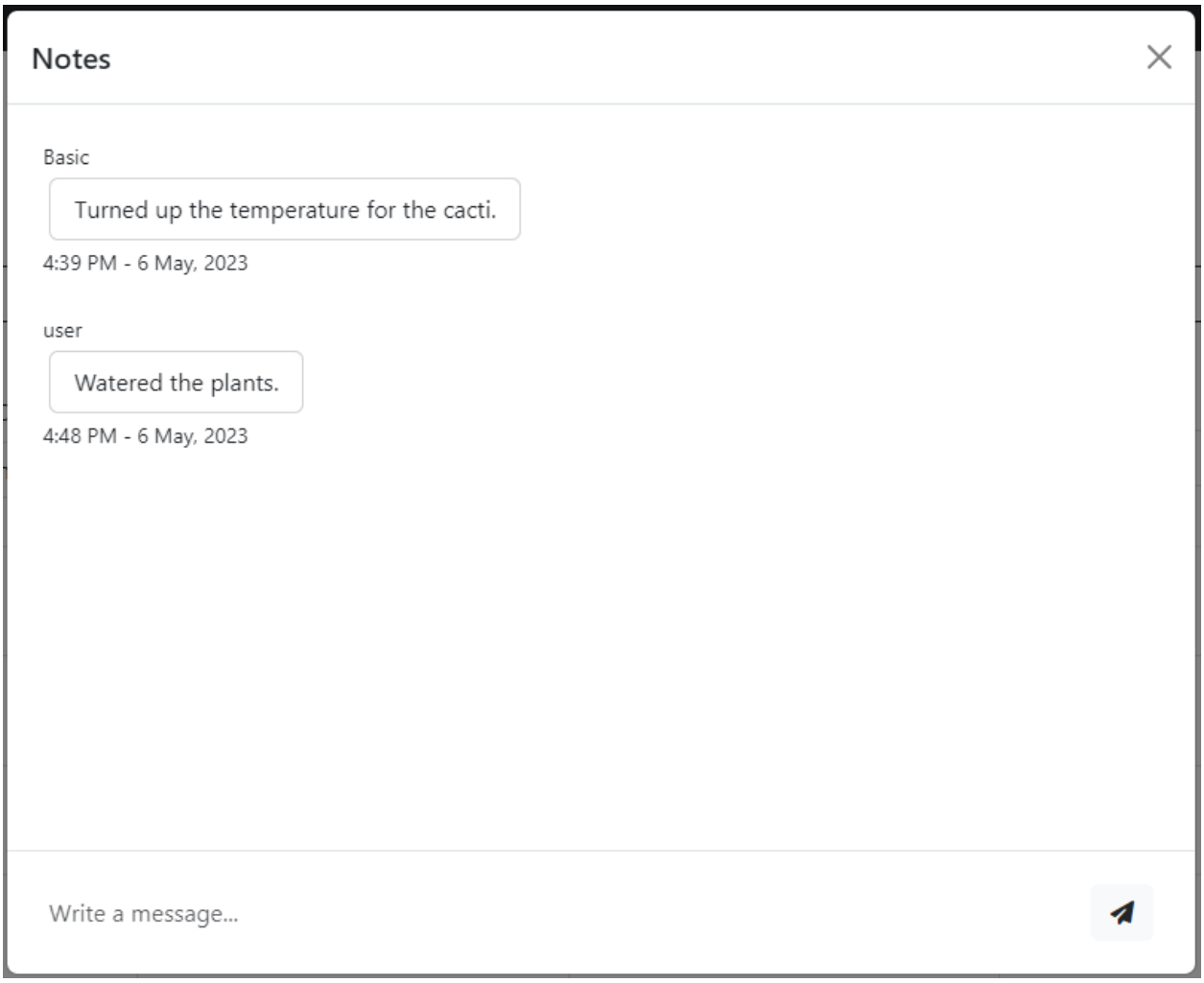
Should an Admin wish to delete an experiment, they would need to click on the delete button of the experiments section in the room page to delete the experiment. This will bring up a popup asking the Admin to confirm deletion of the experiment.



2.7) Messages

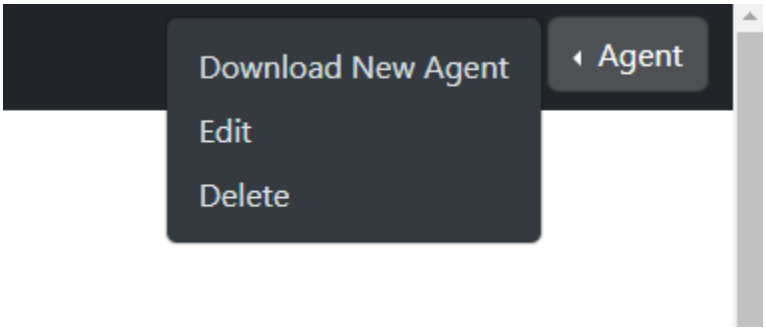
On the room page, directly underneath the name of the Room in the Room page, there is button that will bring up the text chat related to the room:

The pop-up will appear as such with the ability for any user to write and submit message related to the room by clicking on “Write a message…” section, writing a message and then pressing the paper airplane button to send the message. The message sent will display the user who wrote it and the timestamp of when they did.



2.8) Agent Management (Admin Only)

In the top right corner of the Room page, a button will appear for Admin accounts that will allow them to edit, delete, or download a new Agent related to the room. An agent, as detailed in this document, is a process that automatically gathers the sensor data from the rooms to display them into the Greenwatch application. Clicking on this button will give a dropdown of the options an Admin may be able to interact with the agent with. Selecting “Delete” will delete the agent from the room and cease it from gathering any new data. Selecting “Download New Agent” will automatically download a version of the agent that is connected to the Room it was downloaded from. As detailed later in this document, an downloaded agent on a USB is able to be transferred to a Raspberry Pi to collect sensor information from it. Clicking “Edit” will allow the Admin to modify the duration of the measurements taken and the ip address of the agent itself.



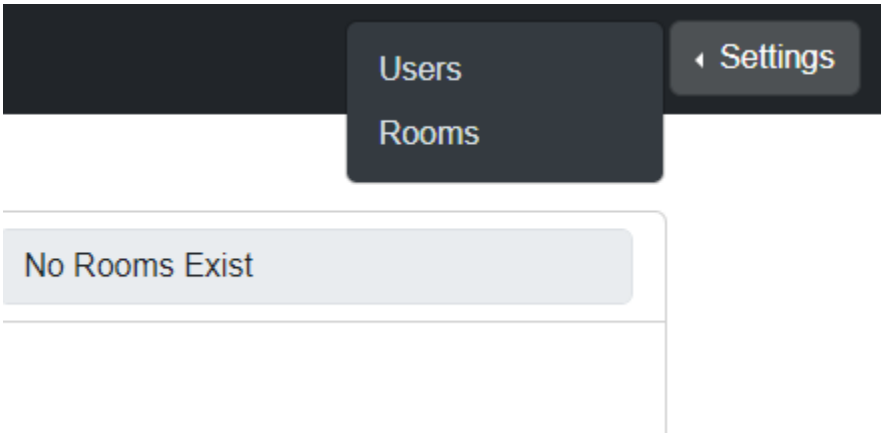
3. User Management

3.1) Admin Privileges

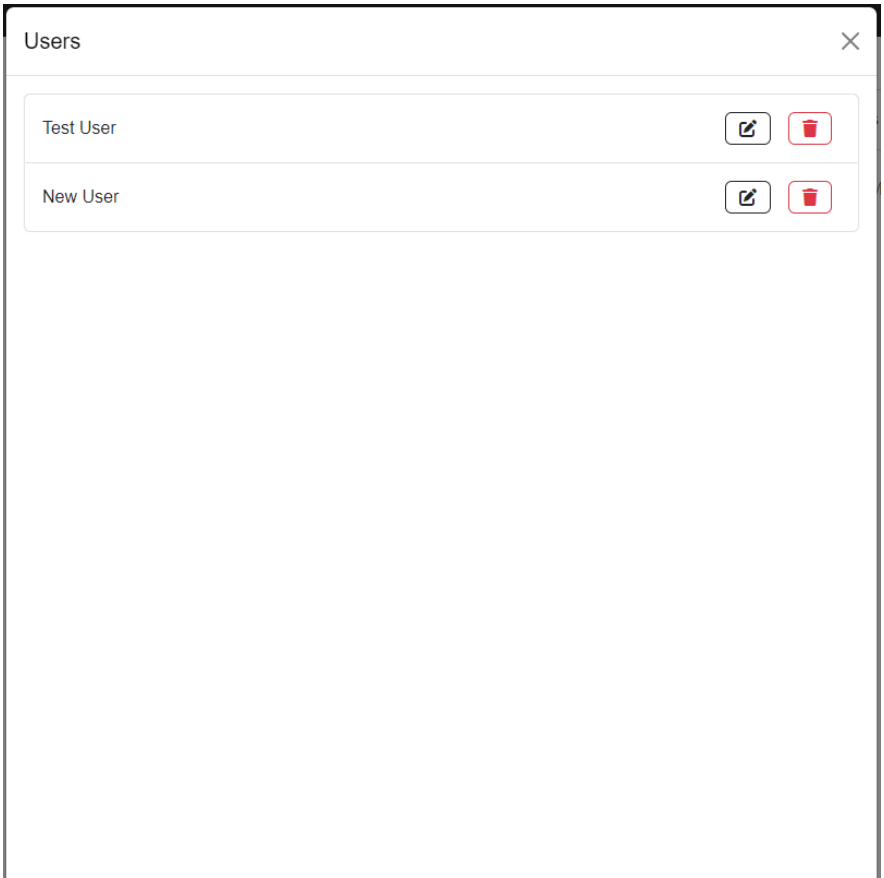
An admin user is afforded a much wider array of privileges and actions than that of a typical user. For instance, only an Admin is capable of Adding new rooms and users from the homepage, interacting with the Agent from the Room page, and modifying the experiments from the Room Page as well. A normal user is only capable of viewing information, interacting with the graphs, only viewing the experiments, and writing comments in the notes section of a room page. All buttons related to Admin Privileges do not appear for a Normal User.

3.2) Adding, Removing, Editing Users (Admin Only)

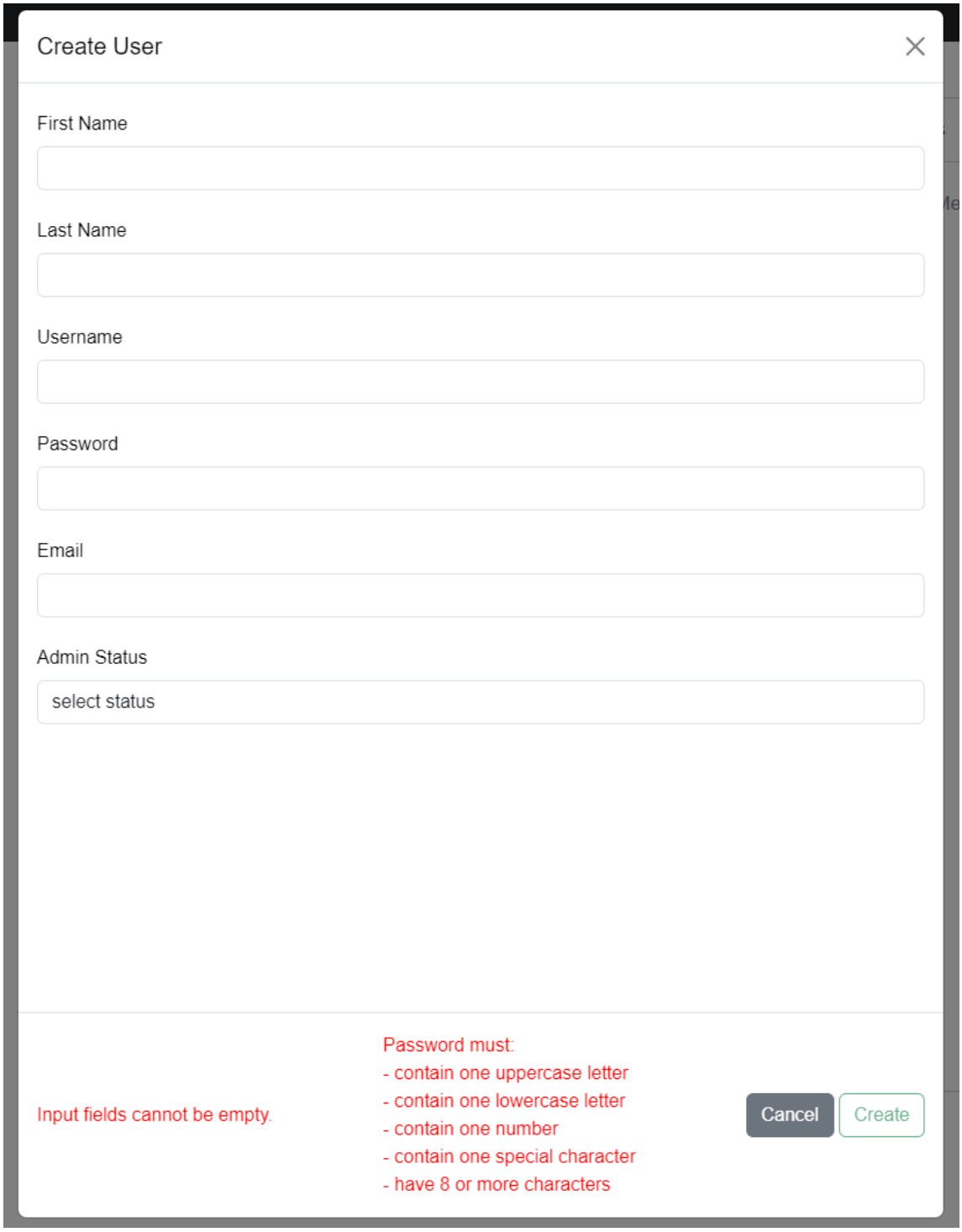
From the Homepage, in the top right corner there is a drop down on the settings button that allows the Admin to add new Users to the system including other Admins as well as editing or deleting them.



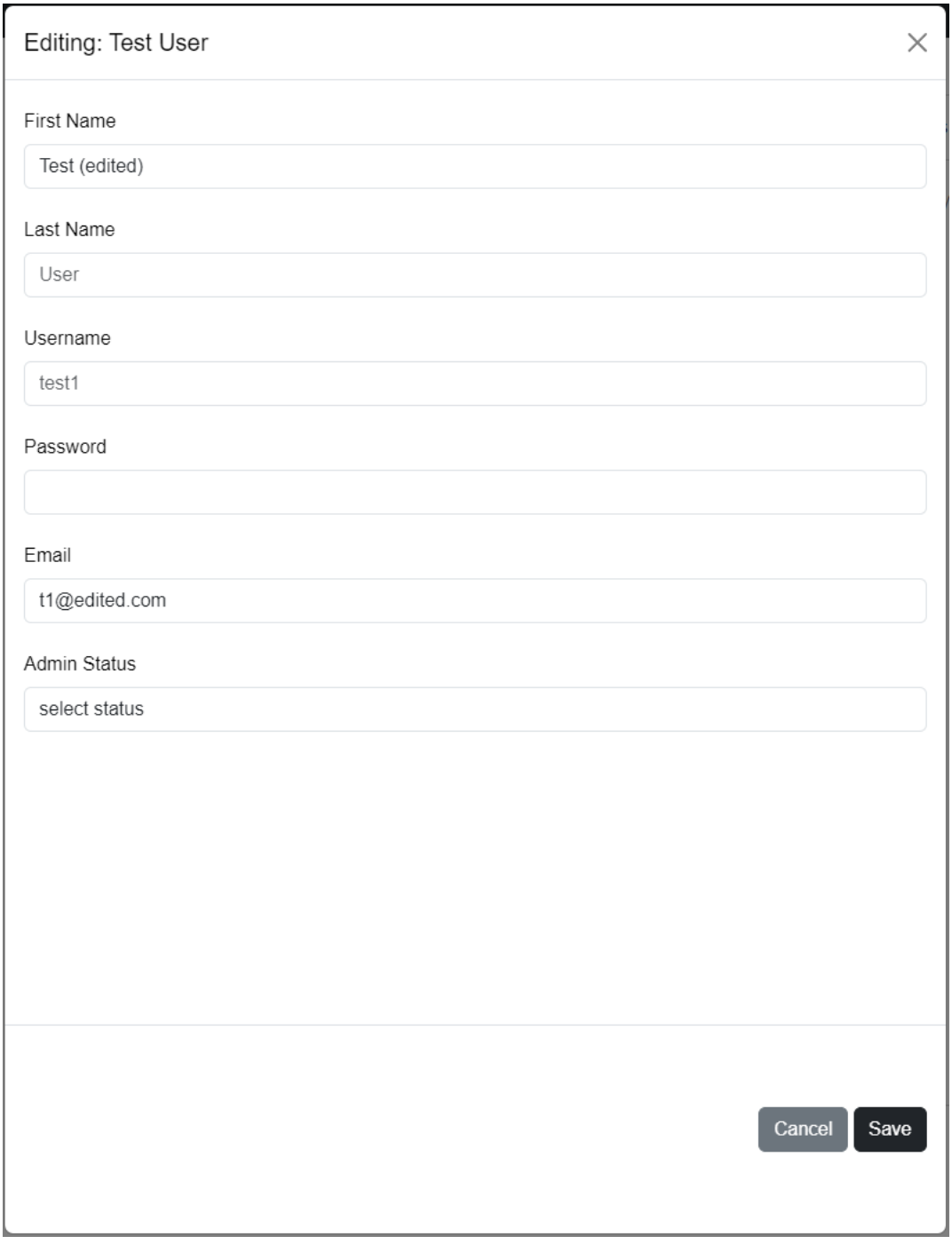
Selecting Users will bring up the user list as a new pop-up. To create a new user, simply press the “Add User” button



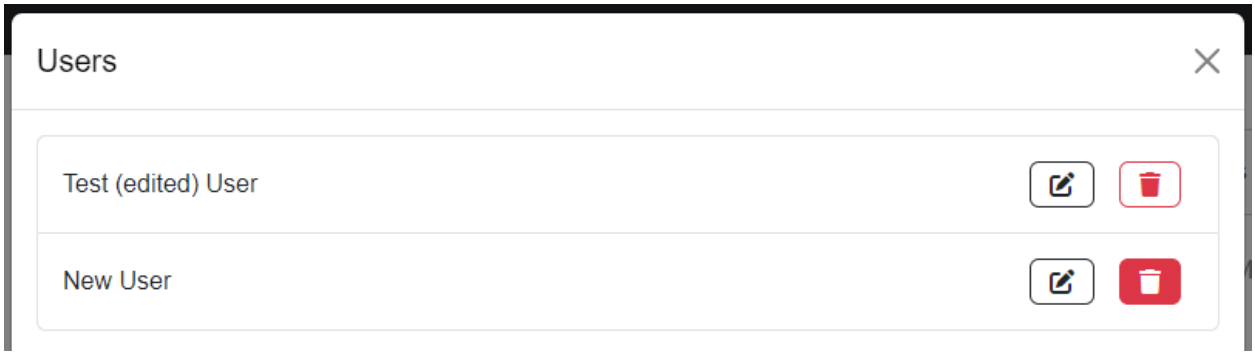
This will bring up a new pop-up that will prompt the Admin to enter the user's information and whether they should be granted Admin Status. All fields must be filled and passwords must contain 1 uppercase letter, 1 lowercase letter, 1 number, 1 special character, and have 8 or more characters in total.The system will not allow you to create a user until all conditions are met in which case you simply click on the "Create" button in the lower right hand portion of the pop-up:



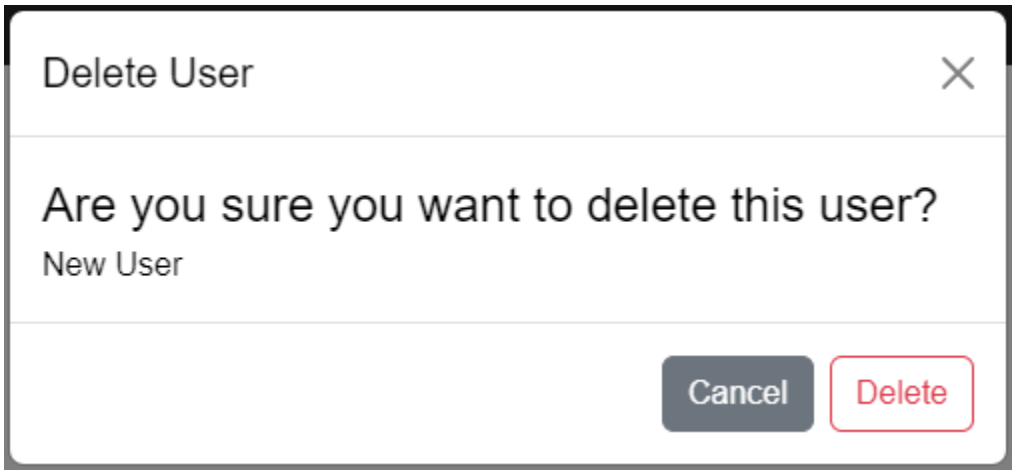
Clicking on the Pen-paper icon of the user list pop-up will allow an admin to edit that user's information, bringing them to a similar pop-up screen as the user creation. Simply make any changes and then save your changes with the button in the lower right hand corner of the screen.



In order to delete a user, an Admin must go to the User list popup and select the trashcan next to the user they wish to remove:



This will prompt another pop-up asking if the Admin is certain of the decision, simply click delete and the user will be deleted from the system.



4. Hardware

4.1) Explanation

What is the agent? Ultimately the agent is a raspberry pi that collects data then packages the data to send it to the server. Hardware wise there are many components that can be integrated, though the main items that come along the raspberry pi are wires, whether they be solderless jumper cables or not. Another useful extension is breadboards that can extend the capabilities of the pins of the raspberry pi. So, what collects the data? Sensors are the main drive-in projects like these when it comes to observing environmental changes, and when it

comes to sensors there are a variety of kinds to take into consideration. For instance, the one used on the system is called a Sense HAT so what is this, overall, it is a big sensor with components like humidity/temperature, air pressure, magnetometer sensors that are integrated into it, it also contains an 8x8 RGB board which can be used as an output screen if wanted. While there are other types of “Sense HATs” out there, the sensors themselves are also sold individually, like the photoresistor that was implemented to the agents as well.

When it comes to the hardware, the first thing to encounter is the case. It is an easy proves:

1. First unscrew the main panel (while being careful that any attached components get forcibly removed).

2. From there, unscrew the attached components, let it be the sense HAT and the PI board.

3. Finally disconnect or un-attach any not screwed components.

Now the agent system should be completely loose. Now the question is how we get to the programming of the system? To view the operating system of the Raspberry Pi board is to do the following:

1. Have access to a monitor with an HDMI port, have an HDMI cord, have a mouse. and a keyboard that has a USB port, micro-USB power cable.

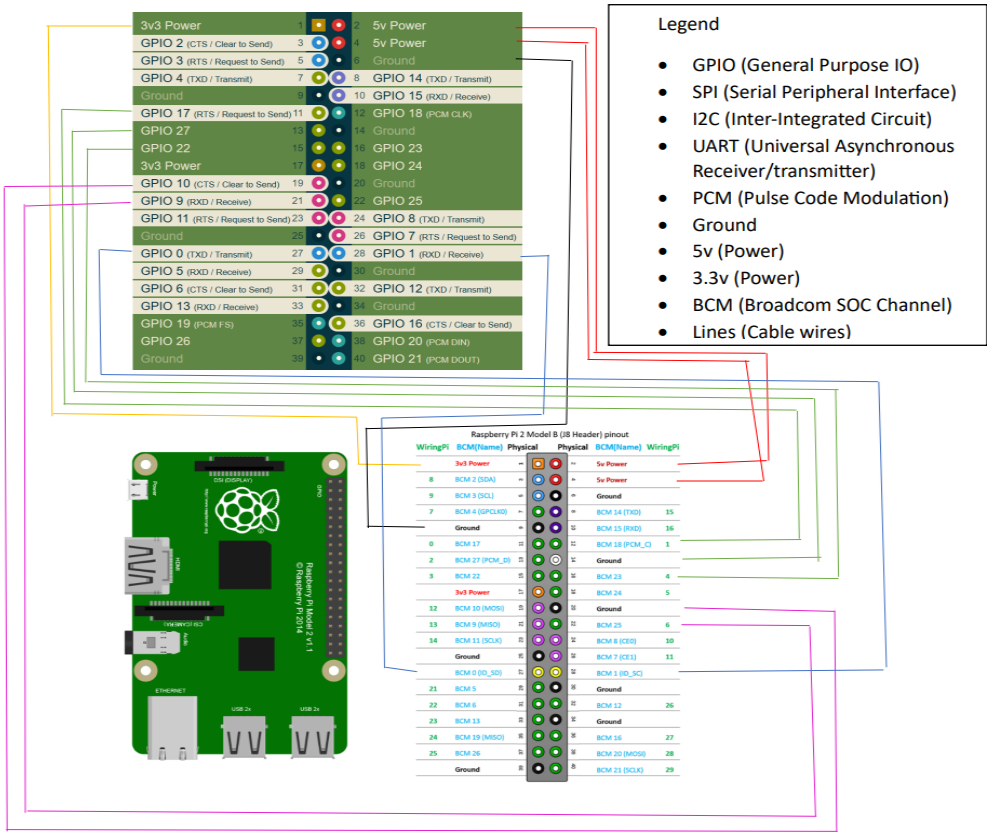
2. Connect the HDMI to the Raspberry pi board and connect the other end to the monitor.

3. Next connect the mouse and keyboard to the Raspberry Pi board via the USB ports

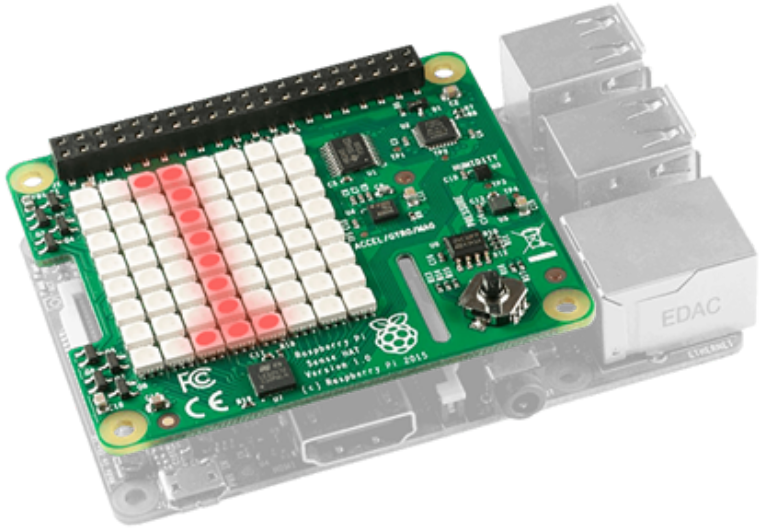
4. From there connect the power cable to an outlet

5. Now the monitor should display like a PC.

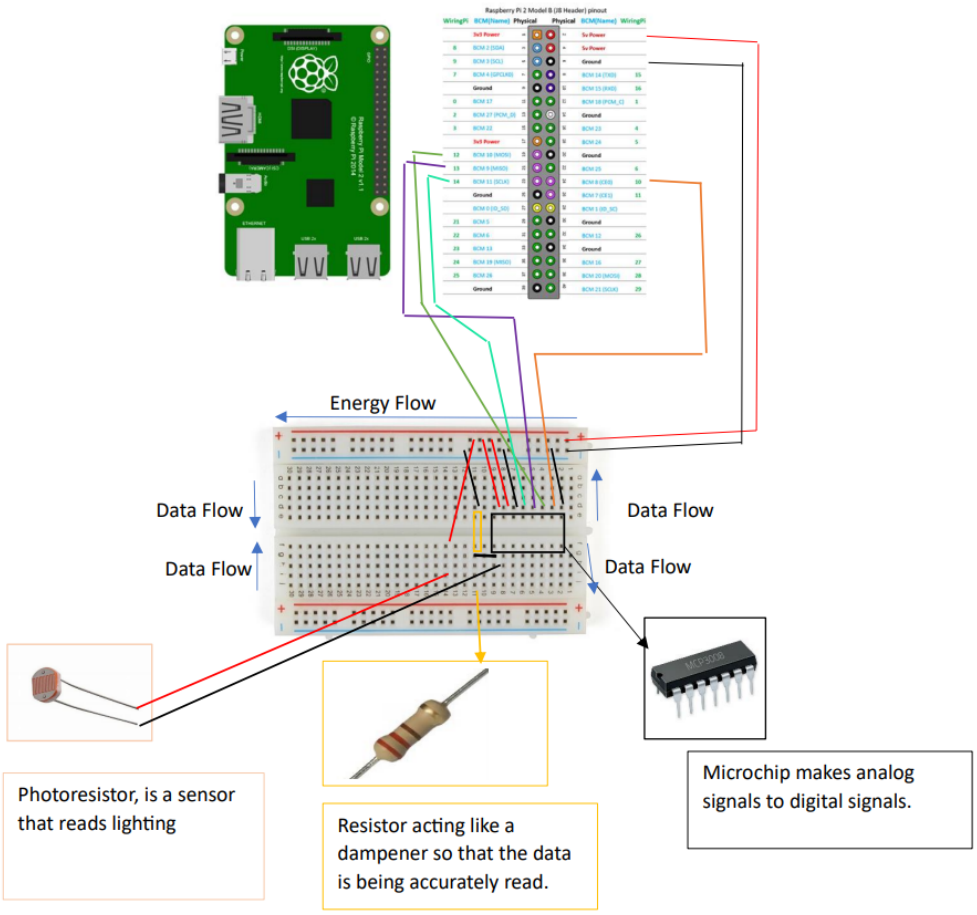
The following is a diagram that can be used to visualize the connections between the hardware:



Or for practice to see how the Sense HAT works, connect it directly as shown below:



The diagram below shows how to connect sensors via breadboard:



4.2) Installation Process

So internally what is going on with the raspberry pi? Well first a Micro-SD card is needed to hold Raspbian (the OS system that the raspberry pi uses):

1. Have an SD card that has sufficient storage for the project.

2. Install Raspberry Pi OS using Raspberry Pi Imager (Preferably with Raspberry Pi website itself).

3. Open or download a SDFormatter of choice.

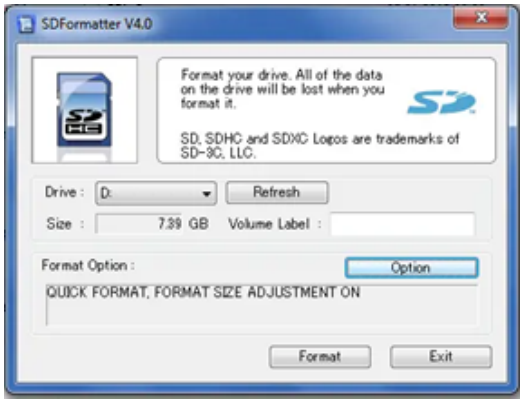
4. Select the SD card in the formatter.

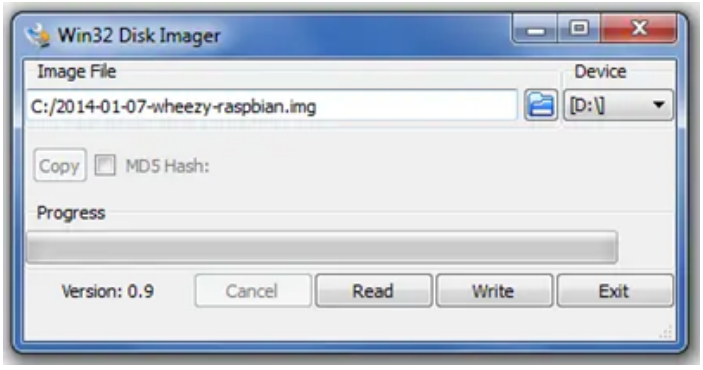
5. Select option “FORMAT SIZE ADJUSTMENT ON”

6. Now that the SD card is formatted accordingly, transfer the Raspbian image.

7. Start Win32DiskImager and select the image and the drive and press Write.

8. Once the writing process is done, the SD card is removable and can be inserted into the raspberry board





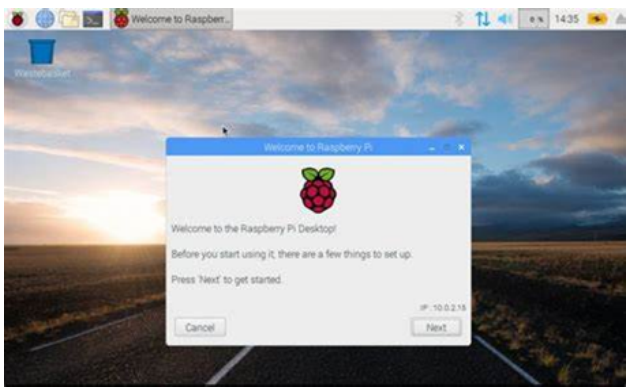
Once done the SD can be inserted onto the raspberry pi, now it can be used and programmed. From here the question is how can I start programming? What will be needed is a monitor alongside an HDMI cord, keyboard, mouse, and power cable (Micro-USB cord) which will be connected to a power supply or outlet. Once everything is connected the following image should be seen first in the monitor, then proceed the installation process:

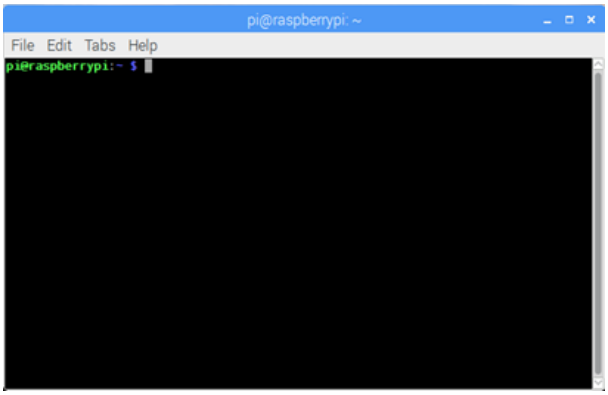
From there, an understanding of enabling certain things in order to get the full capabilities of the raspberry pi. The following example uses SPI:

```
from sense_hat import SenseHat
from spidev import SpiDev

bufferSize = 1024
roomTitle = "Empty Room"

#initializing sensors
sense = SenseHat()

#Rounding function
def round(n, decimal = 0):
    multiplier = 10 ** decimal
    return math.ceil(n * multiplier) / multiplier

#Json encoder
class set_encoder(JSONEncoder):
    def default(self, obj):
        return list(obj)

class MCP:
    def __init__(self, bus = 0, device = 0):
        self.bus, self.device = bus, device
        self.spi = SpiDev()
        self.open()
        self.spi.max_speed_hz = 1000000

    def open(self):
        self.spi.open(self.bus, self.device)
        self.spi.max_speed_hz = 1000000

    def read(self, channel = 0):
        adc = self.spi.xfer2([1, (8 + channel) << 4, 0])
        data = ((adc[1] & 3) << 8) + adc[2]
        return data
```

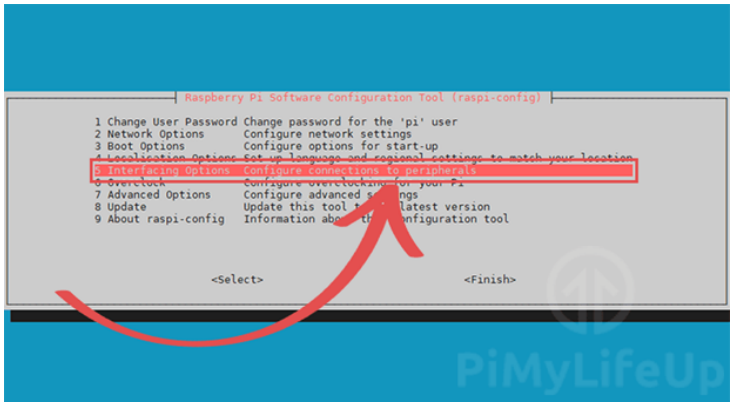
In most cases SPI, which is used for the microchip processor (MCP 3008), is disabled by default and to enable it the following steps is required (will need an external keyboard and mouse to move through the OS, similar to a PC):

1. Open the terminal in the Raspbian OS



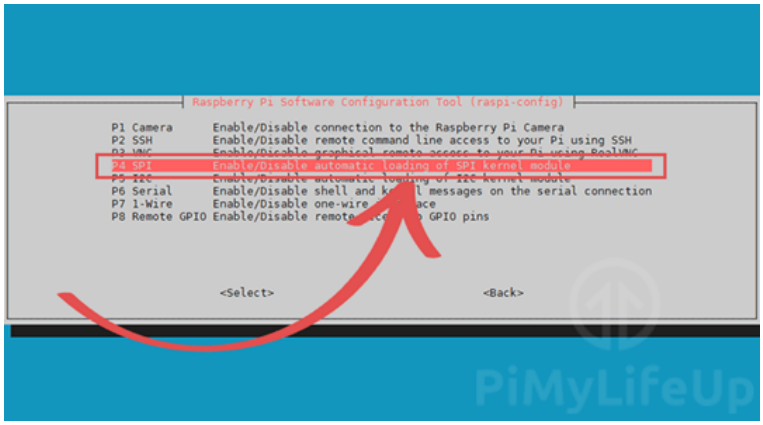


2. Next in the terminal type “sudo raspi-config”



3. Within the configuration use the arrow keys to maneuver to select the option “5. Interfacing options”

4. From there select the option to enable SPI, which will be “P4 SPI”



5. When asked to enable select Yes

6. Now you can escape the configuration using “ESC”

7. From there the terminal will show itself again, and in order to fully integrate the enable “sudo reboot” needs to be inputted in the terminal in order for the board to be rebooted and updated