Embdedded Systems and IoT - a.y. 21/22

# Assignment #3: Smart Garden Report

This is a short report explaining the modeling choices made along the development process of this assignment.

## Requirements

All the requirements of the system can be found here.

## Demo

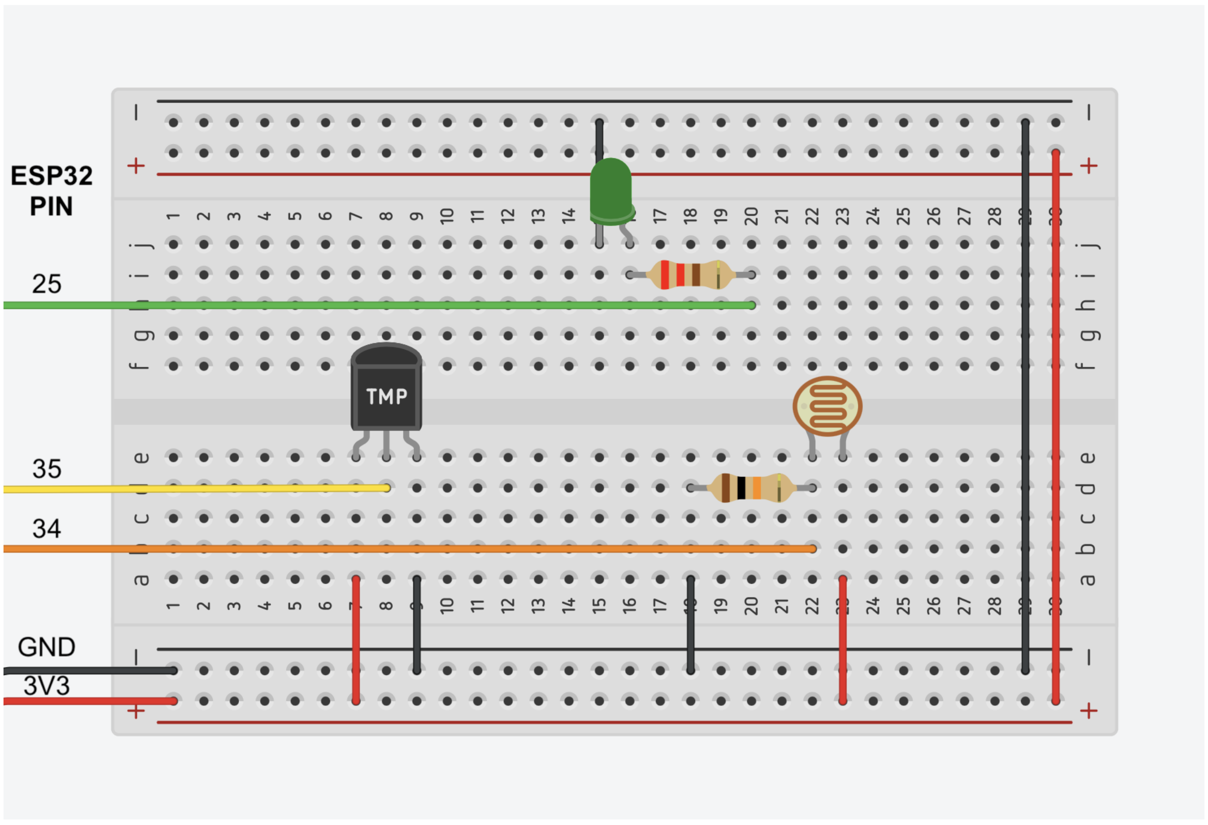
Here a short video demonstrating the logic of the system (hosted on restricted Unibo account).

## Design

### Garden Sensor Board

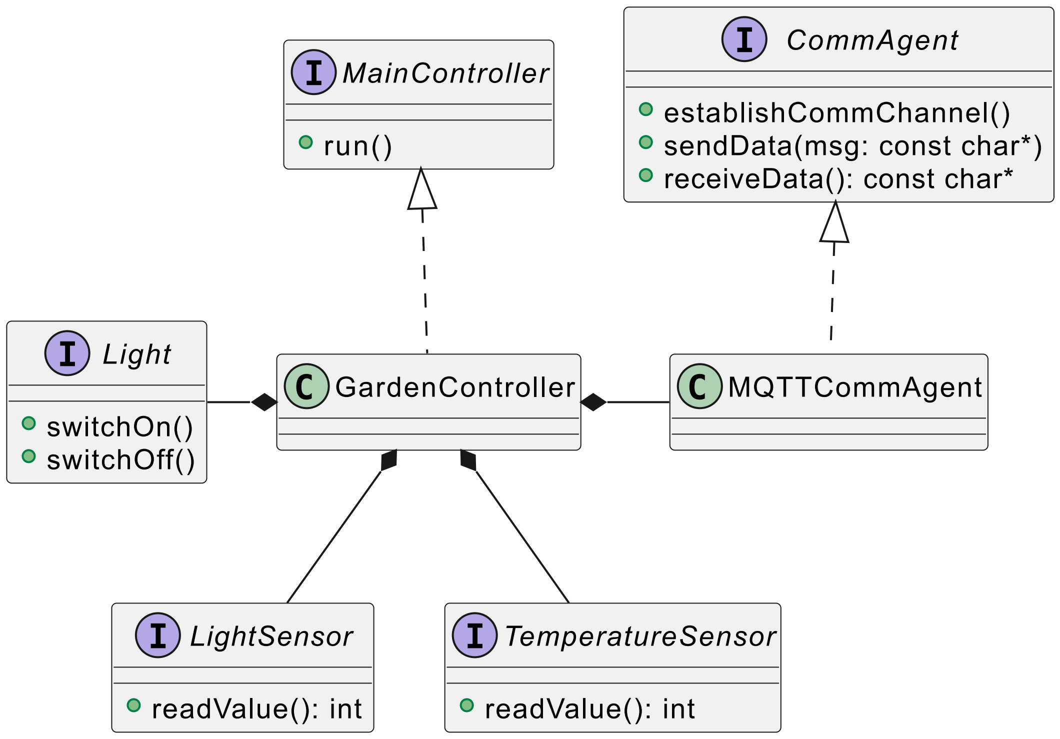
The Garden Sensor Board (ESP) - as described in details in the requirements - is the component which monitors the state of the garden, reading and sending, through MQTT, the sensor data to the garden service app.

Below the schema of the circuit (made with Tinkercad):



The software has been conceived as follows and is presented in the following UML schema:

- `CommAgent` is the agent, i.e. the active component, which exposes a general API in order to takes care of all comunications between the board and the outside world. This interface is implemented by a concrete `MQTTCommAgent` which encapsulates all the logic for connecting, sending and receiving messages through MQTT. This design follows the OCP principle: if it were necessary to communicate also via HTTP, it would be possible to simply add a new concrete implementation of the `CommAgent`.
- `MainController` is the controller of the board and exposes a `run()` method which is periodically called by the main. The concrete controller, the `GardenController`, for each execution of the `run` method reads all the sensor status, serializes them inside a Json format, and delegates the data sending to the `MQTTCommAgent`.



### Garden Service

The garden service is the subsystem acting like a bridge between all other subsystems: it receives via MQTT the sensor data measured by the garden sensor board and forwards them through the serial line to the garden controller; moreover, it stores them in order to update the garden dashboard when a new `GET` request has been performed.

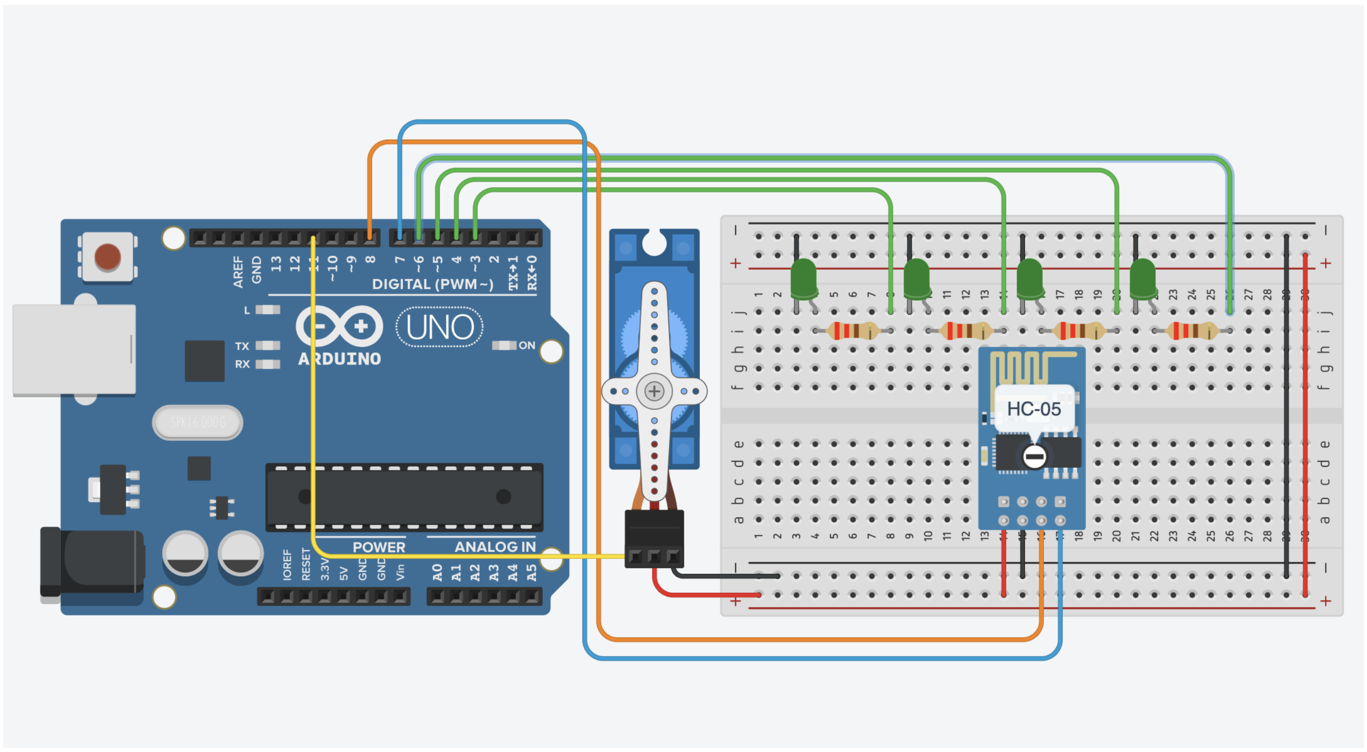
The main components of the subsystem are:

- `HTTAgent`: active component handling HTTP requests (implemented in Vert.x);
- `MQTTAgent`: active component handling MQTT communications (implemented in Vert.x);
- `SerialListener`: component receiving messages sent on the serial line in order to update the state of the garden.

### Garden Controller

The garden controller is the embedded subsystem which controls the irrigation system (simulated by means of a servo motor) and the lighting one (simulated by four LEDs).

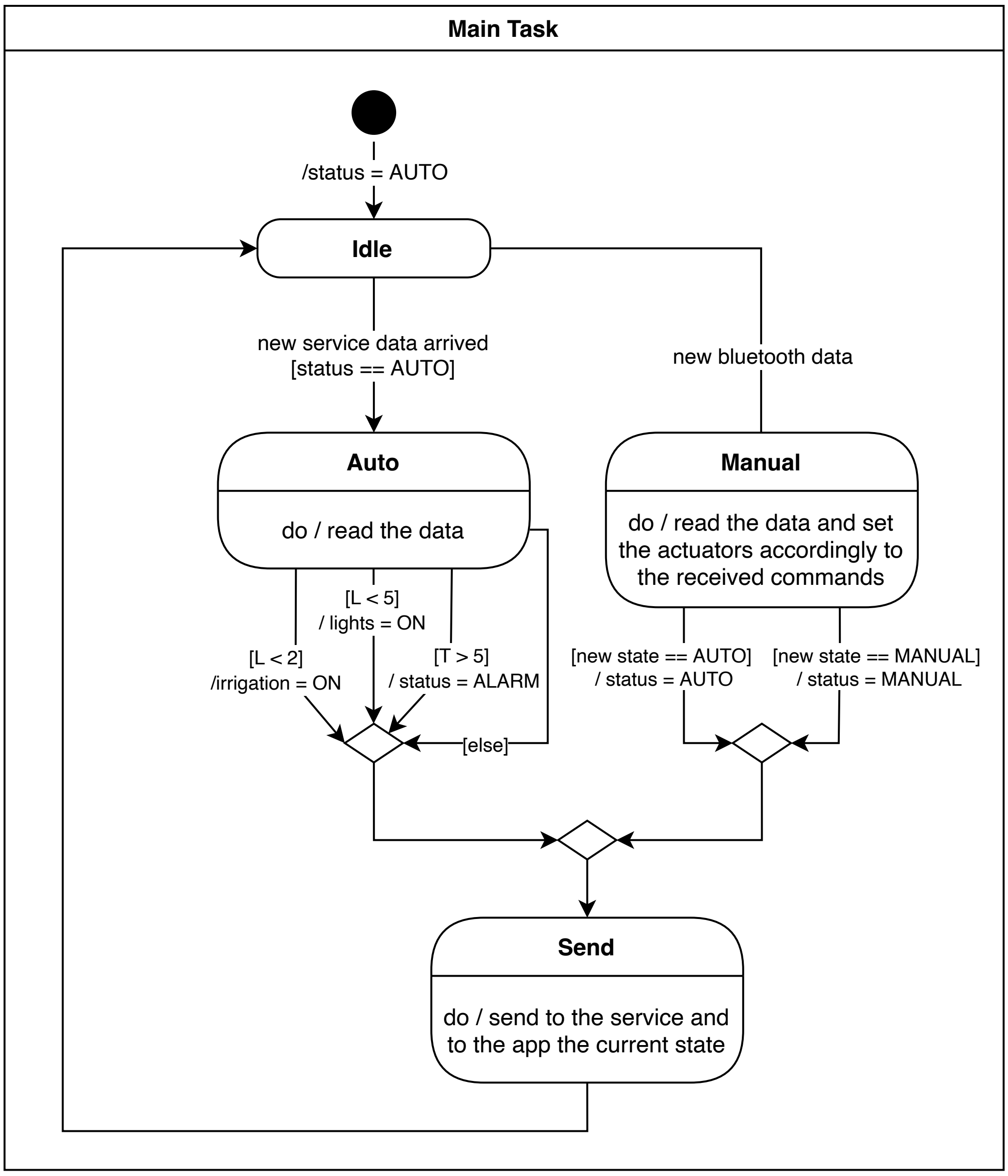
Below the schema of the circuit (made with Tinkercad):



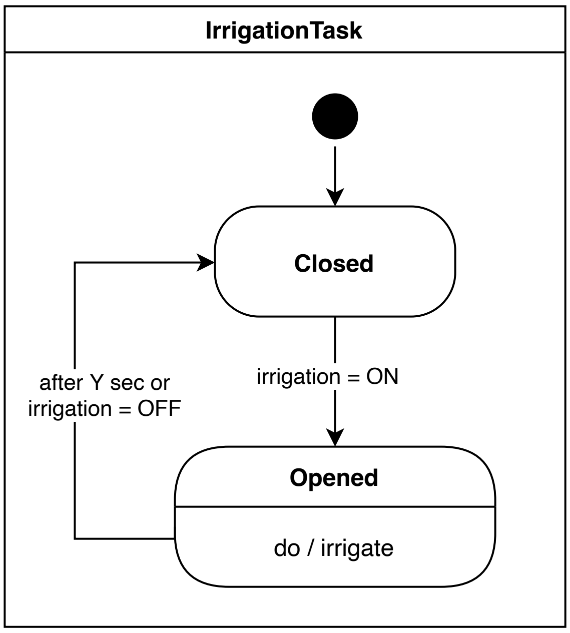
It has been conceived using a **tasks-based architecture** and **synchronous Finite State Machines** with a **fully-static scheduler**. For this purpose have developed 2 different tasks, with different levels of abstraction: a **Main Task** and **Irrigation Task**.

The **Main Task** is the core task of the (sub-)system. It checks whether new data has arrived, both via the Serial line from the garden service or via bluetooth from the Android App. In both cases, when such an event happens, it reads the data and set up the system accordingly to them. Finally, it sends through the Serial line and blueetooth the new state of the garden in order to propagate the state info in the other subsystems.

This task is executed every 500ms.


Main Task
/status = AUTO
Idle
new service data arrived [status == AUTO]
new bluetooth data
Auto
do / read the data
Manual
do / read the data and set the actuators accordingly to the received commands
[L < 5] / lights = ON
[L < 2] /irrigation = ON
[T > 5] / status = ALARM
[else]
[new state == AUTO] / status = AUTO
[new state == MANUAL] / status = MANUAL
Send
do / send to the service and to the app the current state

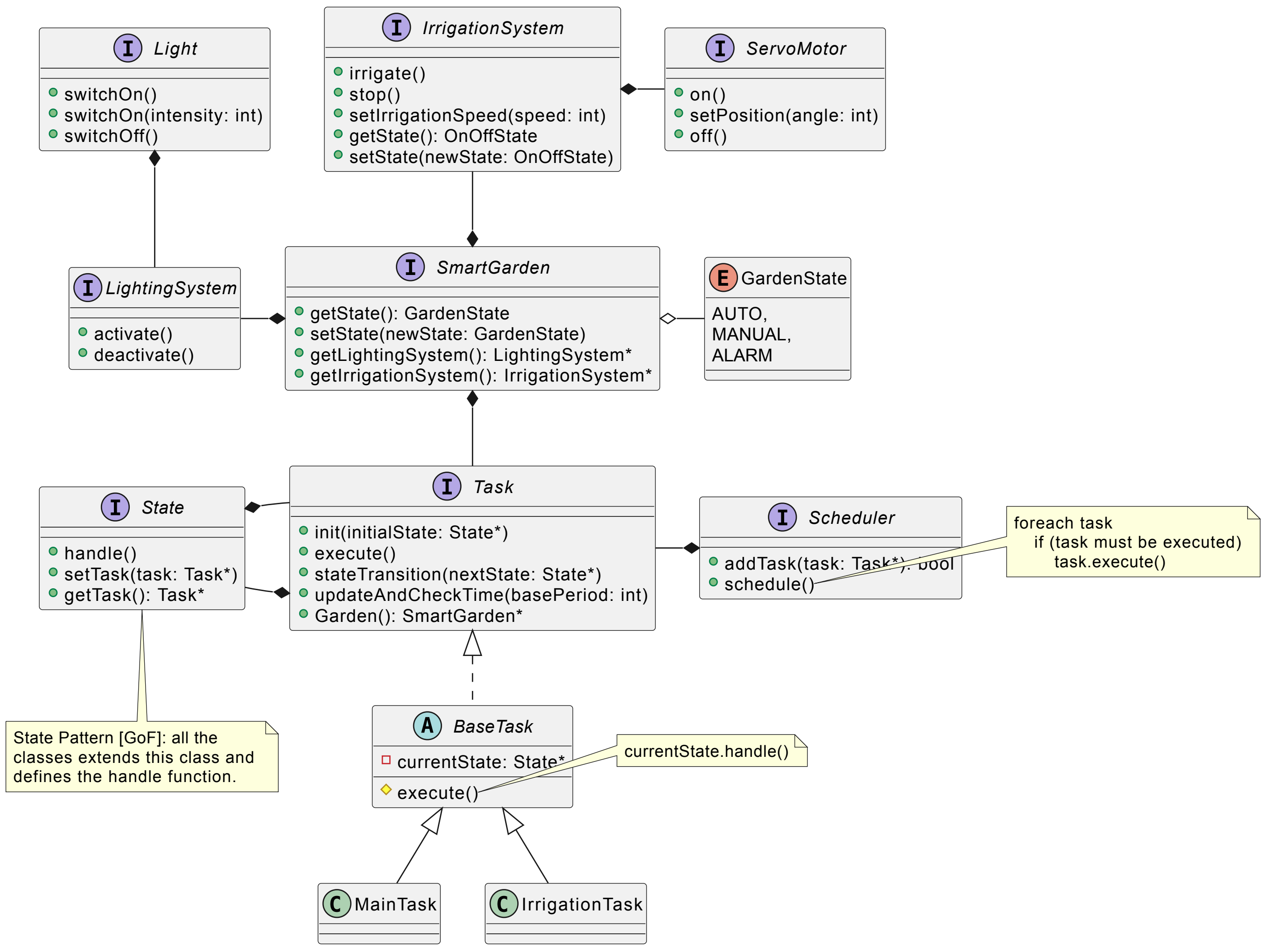
The **Irrigation Task** is the task that is responsible for the irrigation subsystem and is composed of only two states: `On` and `Off`. It's executed every 100ms.



**[NOTE 1]** the communication between the two tasks is achieved with a shared variable in which is stored the state of the irrigation system (in the source code this variable is encapsulated inside the `IrrigationSystem` class and exposed via a getter).

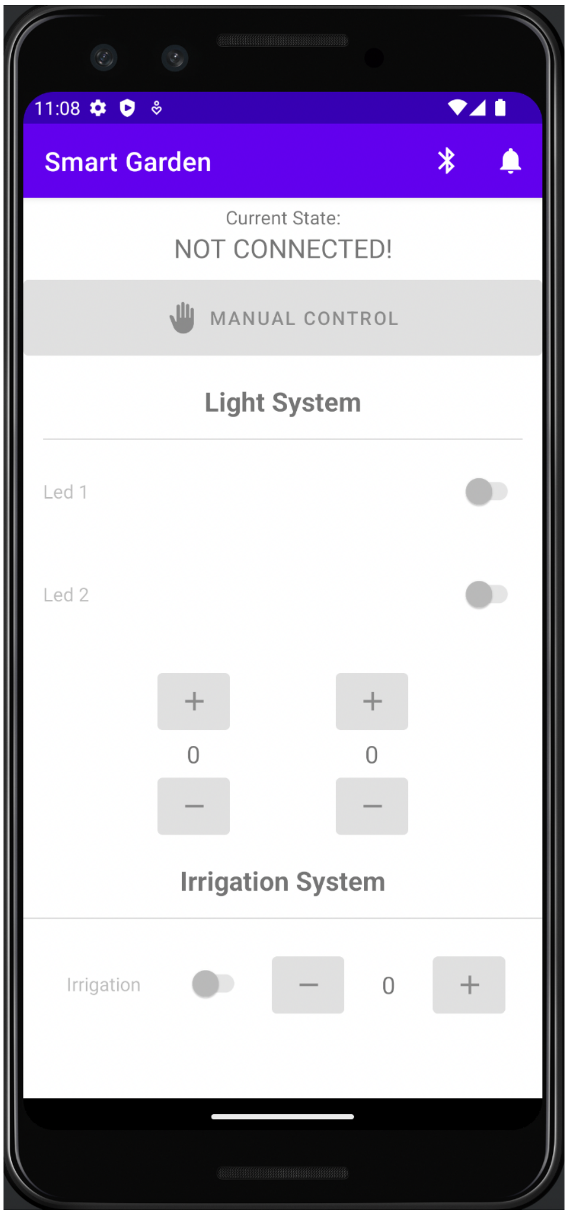
**[NOTE 2]** it could be implemented an another task which takes care of the lighting subsystem. However, for the actual requirements of the system, it's unnecessary (and would generate a lot of unnecessary boilerplate) because the (de)activation of the lighting subsystem is "atomic": is instantly executed when new data arrive, differently from the irrigation system which requires to be continuously updated even when no data is coming.

The OO organization of the code is described from the following UML diagram:



## Garden Mobile App

The mobile app makes it possible to manually control the irrigation system and lighting one interacting with the garden controller via Bluetooth.



## Garden Dashboard

It is a simply html page with linked a JS script which periodically sends an ajax `GET` request to the service to retrieve the last set of data (in Json format) and display them in a chart line, in addition to the garden state info.

# Smart Garden Dashboard

## Third Assignment of *Embedded System & IoT* @ UniBo

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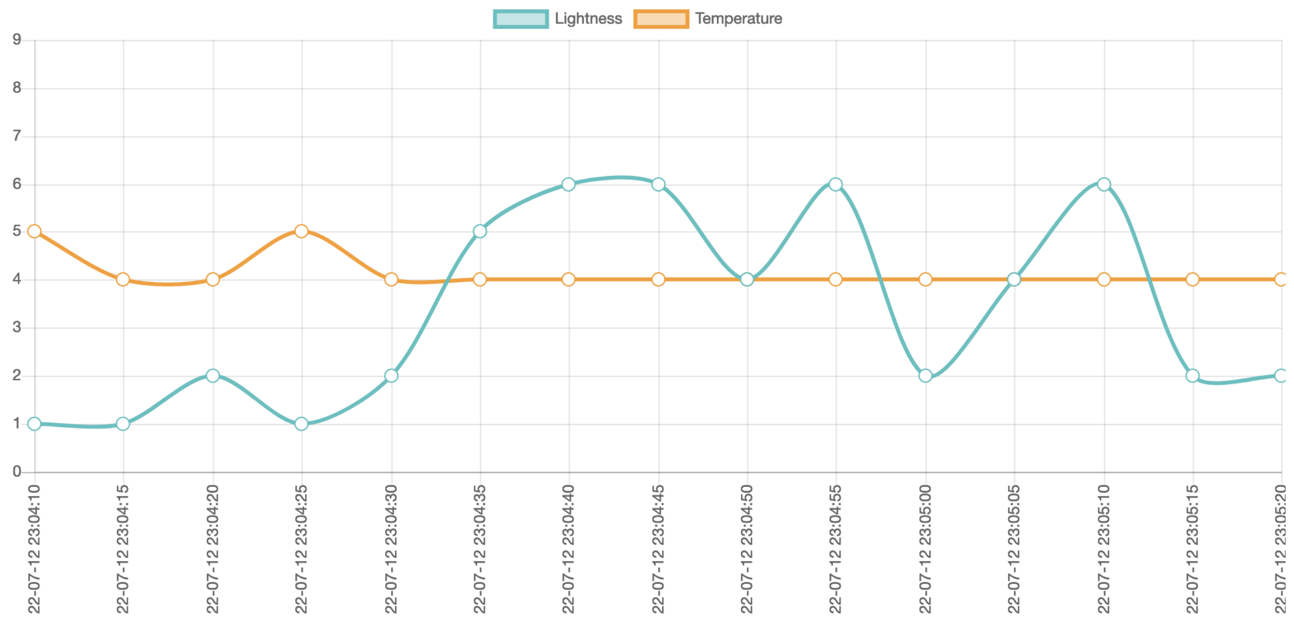
### Garden State: Auto


Lightness
Temperature
22-07-12 23:04:10
22-07-12 23:04:15
22-07-12 23:04:20
22-07-12 23:04:25
22-07-12 23:04:30
22-07-12 23:04:35
22-07-12 23:04:40
22-07-12 23:04:45
22-07-12 23:04:50
22-07-12 23:04:55
22-07-12 23:05:00
22-07-12 23:05:05
22-07-12 23:05:10
22-07-12 23:05:15
22-07-12 23:05:20